Hayward Road/Main Street (Route 27) Intersection Study

FINAL REPORT

Prepared for

Town of Acton, Massachusetts

Prepared by

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Introduction

Acton is located approximately 25 miles west of Boston along Route 2 between Route 128 and I-495. Route 27 (Main Street) bisects Acton in a northeast to southwest direction. In this area, it carries approximately 17,000 vehicles per day. The recently completed Public Safety Facility (PSF) is located within 300 feet of the Route 27/Hayward Road intersection. The project location is shown in **Figure 1.** Hayward Road is a local collector street. In addition to a large residential population, Hayward Road services the Regional High School and a manufacturing facility with significant truck traffic.

Purpose

The Town of Acton commissioned a study of this intersection in 1997. The intersection was also recently studied as part of the *Route 27 Corridor Study* completed in 2001. These studies recommended modifications to the geometry and signalization of this intersection. The Town wishes to update and expand on the above studies with respect to the Route 27/Hayward Road intersection and to determine more precisely the impact of signalization (or other changes) on nearby roads, intersections, and neighborhoods. At the conclusion of the current study and receipt of public input, the Acton Board of Selectmen will recommend to the next Town Meeting either to fund a final design and construct the most favorable option or to make no changes.

Howard/Stein-Hudson Associates (HSH), the consultant, understands that the community is concerned about the possible impacts of signalization and/or other changes to the intersection of Route 27/Hayward Road on neighboring streets and intersections. For this project, HSH worked concurrently on both neighborhood and corridor-wide impacts. Thus, the study area encompassed both the Route 27 corridor between Route 2 and Brook Street and the neighborhood around the intersection of Route 27/Hayward Road, including Musket Drive, Jefferson Drive, John Swift Road, and Coughlin Street.

The community also has concerns such as safety near the Patriots Hill Pool, the inclusion of sidewalks on neighborhood streets, etc. Some of these concerns may not relate directly to the intersection study. Although addressing them may be desirable, this study focused on issues related to potential changes at the intersection. This report notes other community concerns and addresses them in a limited fashion, but larger issues should be addressed through other community planning processes.

Figure 1: Locus Map

Study Area

The study area for this project is bounded by Brook Street to the north, Route 2 to the south, and Washington Drive to the northwest, and consists primarily of Main Street (Route 27). The study area includes 12 intersections along Main Street (Route 27) from the intersection with Route 2 Eastbound Ramps north to the intersection with Brook Street and the intersections of Hayward Road/Jefferson Drive and Musket Drive/John Swift Road.

As shown in **Figure 2,** the 12 study area intersections are:

- Hayward Road/Main Street;
- Hayward Road/Jefferson Drive;
- Musket Drive/John Swift Road;
- Route 2 Eastbound Ramps/Main Street;
- Route 2 Westbound Ramps/Main Street;
- Public Safety Facility South Driveway/Main Street;
- Public Safety Facility North Driveway/Main Street;
- Musket Drive/Coughlin Road/Main Street;
- Taylor Road/Main Street;
- Newtown Road/Concord Road/Main Street;
- Nagog Hill Road/Main Street; and
- Brook Street/Main Street.

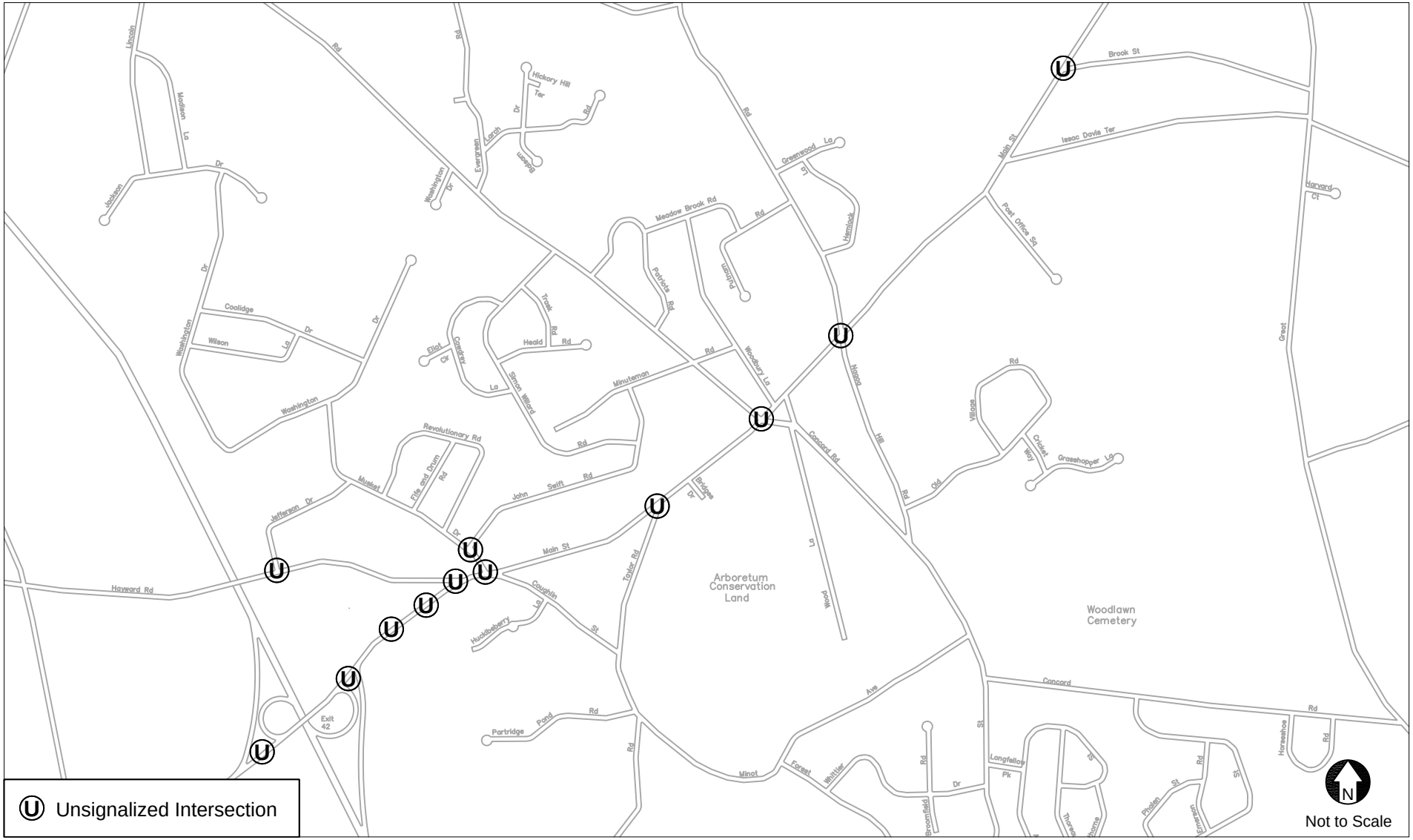


Figure 2: Study Area Intersections

Identifying the Issues

The first step in any successful project is to engage the community and stakeholders in the process and begin a dialogue about issues and opportunities. This was accomplished through a number of different means, including stakeholder interviews, a community meeting, and an unstructured comment sheet handed out at the meeting. The goal of the process was to encourage people who know the Hayward Road/Main Street intersection and the Route 27 corridor to describe in their own terms their experiences and issues with the intersection and the corridor.

Stakeholder Interviews

HSH conducted 8 interviews with residents, abutters, people who drive through the Main Street/ Hayward Road intersection, and Town officials, obtaining detailed and insightful information.

Questions dealt with:

- how they experience the intersection (as a driver, abutter, dog-walker, et al.);
- if they thought there were problems and what specifically was wrong;
- what they thought should be done to address the problems they identified;
- if there was anything that should not be changed at or near the intersection; and
- other comments or suggestions.

In general, those interviewed said the intersection is or feels unsafe. This feeling of danger was attributed to speeding on Main Street, near-accidents involving cars turning left quickly from Hayward Road, and general confusion at the intersection. Improving safety for cars, trucks, and pedestrians at the intersection was a theme of the interviews, with a variety of suggestions offered for making it safer. Three interviewees considered the area unsafe to walk or ride a bicycle through, making it hard to walk to the school complex on Hayward Road. Half of the interviewees said a signal would solve the safety problems, and half thought the problems would be addressed if the design of the intersection were improved to correct geometric deficiencies.

None of those interviewed considered anything in the intersection “off limits” if modifying or removing something would help improve safety. Land takings were deemed acceptable to help improve safety. A number of people interviewed stressed the need for context-sensitive solutions for the intersection. The solutions should not dramatically change the look and feel of the area and should not shift a problem to another location or neighborhood.

Community Meeting

HSH held the first community meeting for the project on October 10, 2007, at Town Hall. At the first community meeting, the study team asked those in attendance to help identify the transportation issues in three areas:

- at the intersection of Hayward Road and Main Street (Route 27);
- in the neighborhood surrounding the Hayward Road/Main Street intersection, including Patriots Hill; and
- along the Main Street corridor between Route 2 and Brook Street.

Over 148 comments were received at the first community meeting, through 20 comment sheets collected at the meeting, faxed, or mailed in after the meeting; and from e-mails. The comments fell into 11 categories, reflecting the broad cross-section of participants in this early part of the study and the breadth of knowledge of the area. **Table 1** summarizes the comments received by category.

Table 1. Public Meeting Comment Summary

Issue Category	Number of Comments
Congestion	1
Driver behavior	6
Enforcement	11
Geometry/design	27
Historic/residential character	7
Neighborhood street impacts	17
Pedestrian issues	26
Route 27 flow	12
Speeding	17
Trucks and buses	13
Other	12

In the two most common categories of comments, “geometry/design” and “pedestrian issues,” several types of comments were offered. Among those related to geometry and design, comments included concerns about trucks turning to and from Hayward Road and the need for a right-turn lane using the Town-owned land on the southwest corner. In terms of “pedestrian issues,” people commented on the location of crosswalks, the lack of continuous sidewalks between Town Hall and Kelley’s Corner, and the speed of cars on Main Street.

Existing Conditions

This section describes the existing roadway geometry, intersection traffic control, peak-hour vehicular and pedestrian volumes, speed data, and crash history.

Existing Roadway Conditions

The study area includes the following roadways, categorized according to the Massachusetts Executive Office of Transportation Office of Transportation Planning classifications:

Hayward Road is an urban collector running east–west between Arlington Street and Main Street (Route 27). Within the study area, Hayward Road consists of a single travel lane in each direction, with a sidewalk along the south side of the road. Hayward Road carries approximately 5,600 vehicles daily. No on-street parking is allowed.

Main Street (Route 27) is an urban principal arterial running northeast–southwest through the Town of Acton between Maynard to the south and Carlisle to the north. Within the study area, Main Street generally consists of one travel lane in each direction, with a shoulder ranging in width from 1 to 5 feet. Main Street carries approximately 17,000 vehicles daily throughout the study area. No on-street parking is permitted, except for several spaces on the southbound side of the road between intersections with Newtown Road and Nagog Hill Road near Acton Town Hall. Sidewalks are provided along at least one side of Main Street throughout the study area.

Jefferson Drive is a local road running northeast–southwest between Musket Drive and Hayward Road. On an average day, Jefferson Drive carries approximately 700 vehicles. On-street parking is allowed. Sidewalks are not present along Jefferson Drive.

Musket Drive is a local road running northwest–southeast between Washington Drive and Main Street and carries approximately 1,200 vehicles daily. On-street parking is allowed. Sidewalks are not present for much of the length of Musket Drive, except near the intersection with Main Street.

Washington Drive is a U-shaped local road. The roadway runs from Jackson Drive south, curves east and intersects with Musket Drive, and then continues east—intersecting again with Jackson Drive. To the east of the second intersection with Jackson Drive, Washington Drive becomes a dead-end street.

Lincoln Drive is a local road running north–south between Newtown Road and Jackson Drive. Lincoln Drive carries approximately 450 vehicles per day.

Charter Road is a local road running north–south between Arlington Street and Massachusetts Avenue. On an average day, Charter Road carries approximately 1,100 vehicles.

Existing Intersection Conditions

The following descriptions of the study area intersections include geometry and pedestrian facilities. All study area intersections are currently unsignalized. It is noteworthy that, as one drives through them, all of the intersections along Main Street, excluding the Route 2 ramps, have similar characteristics that contribute to the driver's perception of the area. It is appropriate to treat Main Street as a unified corridor —not because it serves as a through route in Acton but because of the similarities of the intersections, and the similar improvements needed to maintain that continuity.

Hayward Road/Main Street is a T intersection. Additionally, a residential driveway intersects the north-west corner of the intersection, and 2 more driveways intersect the east side of Main Street. Main Street is the major approach at this intersection; Hayward Road, the minor approach, intersects Main Street at a 45-degree angle. The Hayward Road eastbound approach consists of a 15-foot, shared left-turn/right-turn lane and is stop-controlled. A small grass median separates this lane from the westbound receiving lane. The Main Street northbound approach consists of a single, shared left-turn/through lane, while the Main Street southbound approach consists of a 12-foot through lane and a 10-foot, exclusive right-turn lane. A 1-foot shoulder is provided along the Main Street northbound side, and a shoulder ranging in width from 2 to 7 feet is provided along Main Street on the southbound side. An asphalt sidewalk lines the south side of Hayward Road, on both sides of Main Street north of the intersection, and only along the east side of Main Street south of the intersection. The sidewalk at the southern corner of Hayward Road and Main Street is in poor condition. The damage to this sidewalk was probably caused by frequent overrunning by trucks and buses. Crosswalks are provided across Hayward Road and on the northbound approach of Main Street.

Hayward Road/Jefferson Drive is a T intersection. The Hayward Road eastbound approach consists of a 16-foot left-turn/through lane; the westbound approach consists of a 13-foot through/right-turn lane. Jefferson Drive southbound consists of a 12-foot left-turn/right-turn lane. A sidewalk is provided along the south side of Hayward Road; a crosswalk is provided across the eastbound approach of Hayward Road.

Musket Drive/John Swift Road is a T intersection. The Musket Drive eastbound approach consists of a 15-foot left-turn/through lane; the westbound approach consists of a 15-foot through/right-turn lane. Southbound John Swift Road consists of a 12-foot left-turn/right-turn lane. West of the intersection, a sidewalk lines the north side of Musket Drive; east of the intersection, a sidewalk is provided on the south side of Musket Drive. A crosswalk across the eastbound approach of Musket Drive connects the two sidewalk segments.

Route 2 Eastbound Ramps/Main Street is a 3-approach intersection. The off-ramp eastbound approach consists of a 16-foot left-turn lane and a channelized right-turn lane. The off-ramp left-turn lane is stop-controlled, while the right-turn lane is yield-controlled. The Main Street northbound approach consists of a 13-foot, shared left-turn/through lane. The Main Street southbound approach consists of a 16-foot through lane, with a channelized right turn. Several commercial driveways are provided along the eastern side of Main Street adjacent to this intersection. A sidewalk is provided along the west side of Main Street and a crosswalk is provided across the Route 2 eastbound ramps.

Route 2 Westbound Ramps/Main Street is a 3-approach intersection. The off-ramp westbound approach consists of a 16-foot left-turn lane and a channelized right-turn lane. The off-ramp left-turn lane is stop-controlled and the right-turn lane yield-controlled. The Main Street northbound approach consists of a 16-foot through lane with a channelized right turn. The Main Street southbound approach consists of a 15-foot left-turn/through lane. A sidewalk is provided along the west side of Main Street south of the intersection and along both sides of Main Street north of the intersection. A crosswalk is provided across the southbound approach of Main Street.

Public Safety Facility South Driveway/Main Street is a T intersection. Westbound Public Safety Facility South Driveway consists of a 16-foot left-turn/right-turn lane. The Main Street northbound approach consists of an 11-foot through/right-turn lane; the Main Street southbound approach consists of a 16-foot left-turn/through lane. A sidewalk is provided on the east side of Main Street. A truck-pullout space is provided along Main Street just north of the intersection. A crosswalk is provided across the South Driveway approach.

Public Safety Facility North Driveway/Main Street is a T intersection. The westbound Public Safety Facility North Driveway approach consists of a 16-foot left-turn/right-turn lane. Access to the Public Safety Facility North Driveway is restricted to emergency vehicles only. The Main Street northbound approach consists of an 11-foot through/right-turn lane, and the Main Street southbound approach a 16-foot left-turn/through lane. A sidewalk is provided on the east side of Main Street and a crosswalk across the North Driveway.

Musket Drive/Coughlin Road/Main Street is a 4-leg intersection. The Musket Drive eastbound approach consists of a 16-foot left-turn/through/right-turn lane. A median is provided on Musket Drive at the intersection with Main Street and contains a utility pole. Coughlin Drive is one-way outbound from the intersection of Musket Drive/Main Street. Several residential driveways are adjacent to this intersection. The Main Street northbound approach consists of an 11-foot left-turn/through/right-turn lane. The Main Street southbound approach consists of a 12-foot left-turn/through/right-turn lane. Sidewalks are provided along both sides of Main Street south of the intersection, along the east side of Main Street north of the intersection, and along the south side of Musket Drive. Crosswalks are provided across the northbound approach of Main Street and across Coughlin Drive.

Taylor Road/Main Street is a T intersection. The Taylor Road westbound approach consists of a 12-foot left-turn/right-turn lane and intersects Main Street at an approximately 60-degree angle. This approach is stop-controlled. The Main Street northbound approach consists of an 11-foot through/right-turn lane. The Main Street southbound approach consists of a 12-foot left-turn/through lane. Sidewalks are provided along both sides of Main Street, with no sidewalks along Taylor Road. Crosswalks are provided across Taylor Road and across the southbound approach of Main Street.

Newtown Road/Concord Road/Main Street is a 4-approach intersection. Concord Road intersects Main Street in an angle of approximately 60 degrees. The Newtown Road eastbound approach consists of a 13-foot left-turn/through/right-turn lane and is stop-controlled. The Concord Road westbound approach consists of a 10-foot left-turn/through lane. This approach is stop-controlled, with right turns prohibited. The Main Street northbound approach consists of a 13-foot left-turn/through/right-turn lane. The Main Street southbound approach consists of a 15-foot left-turn/through/right-turn lane. Sidewalks are provided along the north side of Newtown Road, the south side of Concord Road, both sides of Main Street

south of the intersection, and the west side of Main Street north of the intersection. Crosswalks are provided across the northbound approach of Main Street and across Newtown Road.

Nagog Hill Road/Main Street is a 4-approach intersection, with the Nagog Hill Road eastbound approach splitting before intersecting with Main Street to create 2 junction points with Main Street. The southern junction point of Nagog Hill Road and Main Street consists of a 4-way intersection with a channelized left turn/right turn on the northwest corner. The Nagog Hill Road eastbound approach consists of a 12-foot left-turn lane that passes to the left of the delta island after crossing opposing westbound traffic and a 10-foot shared through/right-turn lane. Both Nagog Hill Road eastbound approach lanes are stop-controlled. The Nagog Hill Road westbound approach consists of a 12-foot left-turn/through/right-turn lane and is stop-controlled. The Main Street northbound approach consists of a 16-foot general travel lane. The Main Street southbound approach consists of a 15-foot general travel lane with a channelized right-turn lane. Several residential driveways are adjacent to this intersection. Sidewalks are provided along both sides of Main Street south of the intersection and along the west side of Main Street north of the intersection. A short span of sidewalk is provided on the south side of Nagog Hill Road between Main Street and the first driveway just east of the intersection. Crosswalks are provided across the northbound approach of Main Street and across the eastbound approach of Nagog Hill Road.

Brook Street/Main Street is a T intersection, with the Brook Street westbound approach splitting before intersecting with Main Street to create 2 junction points with Main Street. Brook Street intersects Main Street at an angle of approximately 60 degrees and at an uphill grade. Just south of the intersection, a crest vertical curve on Main Street influences the ability of motorists on Brook Street to see vehicles traveling on Main Street northbound. The Brook Street westbound approach consists of a 13-foot general travel lane at the southern junction and an 11-foot channelized right-turn lane that intersects Main Street at the northern junction. The Main Street northbound approach consists of a 13-foot, shared through/ right-turn lane; the Main Street southbound approach consists of a 12-foot, shared left-turn/ through lane, with the left-turn traffic turning at the northern junction of the intersection and sharing the Brook Street westbound right-turn lane. No sidewalks or crosswalks are provided at this intersection.

Existing Traffic Conditions

To develop an understanding of the existing volumes, the study team conducted data collection on Wednesday, October 24, 2007, along the study area roadways and intersections. Automatic Traffic Recorder (ATR) data were taken over a 24-hour period on Hayward Road, Main Street, Jefferson Drive, Musket Drive, Lincoln Drive, Charter Road, John Swift Road, and Coughlin Road. Additionally, the team conducted turning movement counts at all 12 study area intersections between 7:00 and 9:00 a.m. and between 2:00 and 6:00 p.m.

Existing Roadway Data

The ATR data on the study area roadways obtained on Wednesday, October 24, 2007, consists of roadway volumes, speed, and vehicle classifications. **Table 2** summarizes the findings for the study area intersections. Study area roadway data descriptions are located in the following section.

Table 2. Study Area Roadway Data

Roadway	ADT (vehicles per day)	85th Percentile Speed	Average Speed
Hayward Road	5,584	Eastbound: 33 mph Westbound: 34 mph	Eastbound: 27 mph Westbound: 29 mph
Main Street *(north of Route 2 Westbound Ramps)*	16,934	Northbound: 34 mph Southbound: 37 mph	Northbound: 29 mph Southbound: 31 mph
Main Street *(between Coughlin Street and Taylor Road)*	17,192	Northbound: 42 mph Southbound: 38 mph	Northbound: 35 mph Southbound: 33 mph
Main Street *(north of Brook Street)*	12,159	Northbound: 43 mph Southbound: 43 mph	Northbound: 38 mph Southbound: 37 mph
Jefferson Drive	679	Northbound: 31 mph Southbound: 31 mph	Northbound: 26 mph Southbound: 25 mph
Musket Drive *(between Fife and Drum and Revolutionary roads)*	1,194	Eastbound: 34 mph Westbound: 34 mph	Eastbound: 29 mph Westbound: 30 mph
Musket Drive *(between Washington and Jefferson drives)*	1,150	Eastbound: 29 mph Westbound: 29 mph	Eastbound: 25 mph Westbound: 25 mph
Lincoln Drive	441	Northbound: 30 mph Southbound: 28 mph	Northbound: 26 mph Southbound: 23 mph
Charter Road	1,076	Northbound: 33 mph Southbound: 34 mph	Northbound: 27 mph Southbound: 26 mph
John Swift Road	490	Northbound: 25 mph Southbound: 28 mph	Northbound: 22 mph Southbound: 24 mph
Coughlin Road	740	Eastbound: 29 mph	Eastbound: 24 mph

ADT = average daily traffic (vehicles per day)

Hayward Road

The average daily traffic along Hayward Road near Main Street is approximately 5,600 vehicles per day (vpd). The average speed along Hayward Road is 27–29 mph, depending on direction. The 85th percentile speed varies from 33–34 mph, depending on direction.

Main Street

The average daily traffic along Main Street near Hayward Road is approximately 17,200 vpd. The average speed along Main Street in this area is approximately 33–35 mph, depending on direction. The 85th percentile speed on Main Street is approximately 38–42 mph.

Traffic Volumes

Based on the turning movement counts, the team identified the study area intersection peak hours as 8:00 to 9:00 a.m. and 4:45 to 5:45 p.m. **Figure 3** and **Figure 4** show existing peak-hour turning volumes for the study area intersections. Complete traffic count data are provided in **Appendix A.**

The volumes collected on several roadways in Patriots Hill, including Musket Drive, Jefferson Drive, John Swift Road, and Lincoln Drive, are low. Based on these volumes as well as on a review of similar data collected in previous studies and by the Town's Engineering Department, the study team concluded that motorists driving on Patriots Hill streets are primarily residents of the area. This further emphasizes the need to exercise caution in identifying potential improvements to the intersection of Hayward Road/Main Street to assure that they do not create a cut-through traffic problem for the residential areas.

Existing Traffic Operations

Traffic operations are determined through an analysis of intersection Level of Service (LOS). The study team analyzed LOS and delay at the intersections using Synchro software developed by Trafficware. The latest version, Synchro 6, was used to evaluate the effects closely spaced intersections may have on one another. This software is based on the traffic operational analysis methodology of the Transportation Research Board's 2000 *Highway Capacity Manual* (HCM); LOS and delay (in seconds) are determined based on intersection geometry and available traffic data for each intersection. **Table 3,** excerpted from the HCM, provides LOS criteria for unsignalized intersections. LOS A defines the most favorable condition, with minimum traffic delay. LOS F represents the worst condition (unacceptable), with significant traffic delay. LOS D is generally considered acceptable.

Table 3. Unsignalized Intersection Level of Service Criteria

Level of Service	Average Stopped Delay (sec./veh.)
A	≤10
B	>10 and ≤15
C	>15 and ≤25
D	>25 and ≤35
E	>35 and ≤50
F	>50

Table 4 and **Table 5** show the existing a.m. and p.m. intersection LOS results for the study area intersections. Complete Synchro reports are provided in **Appendix B.**

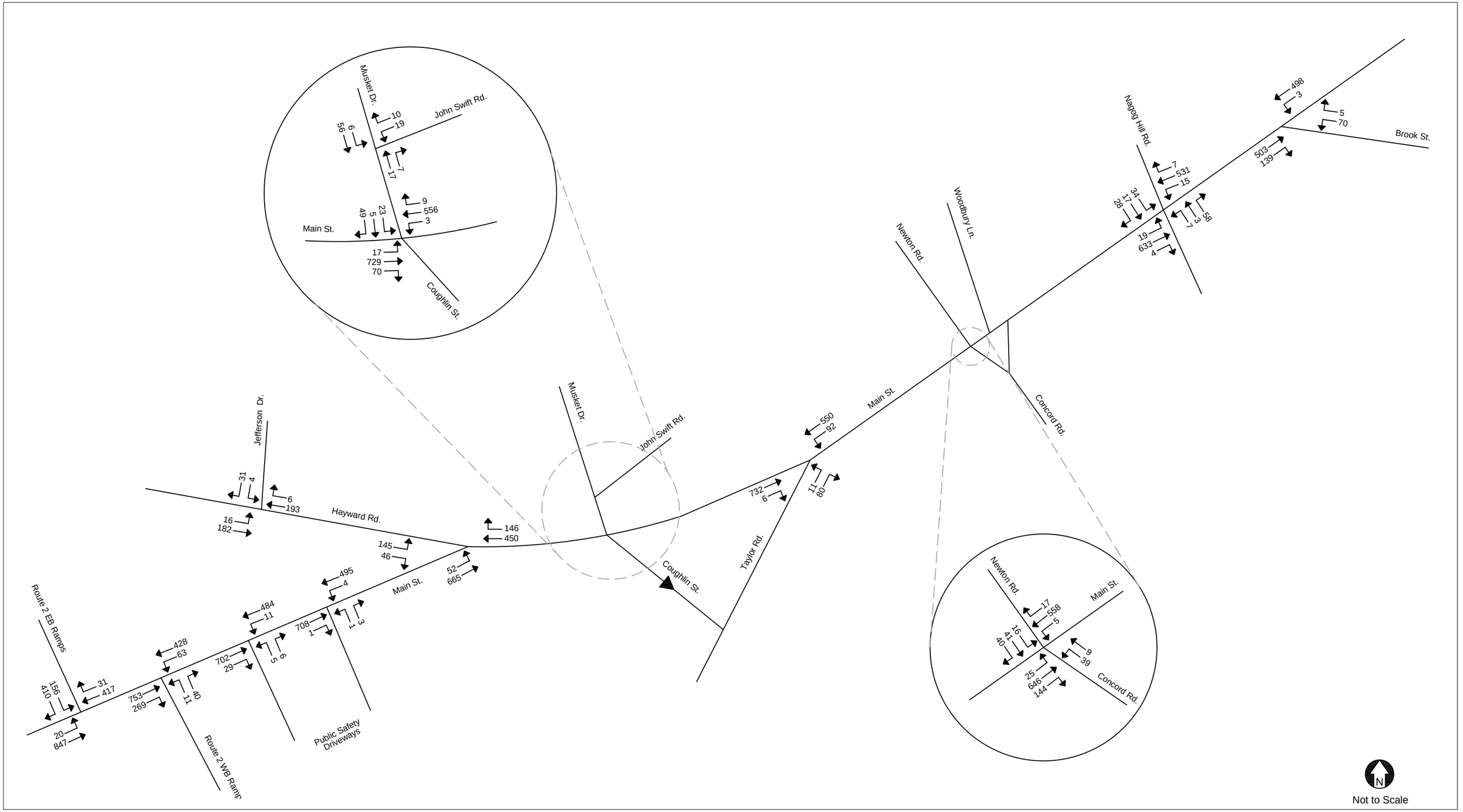


Figure 3. Existing Conditions (2007) Turning Movement Volumes, a.m. Peak Hour (8:00-9:00 a.m.)

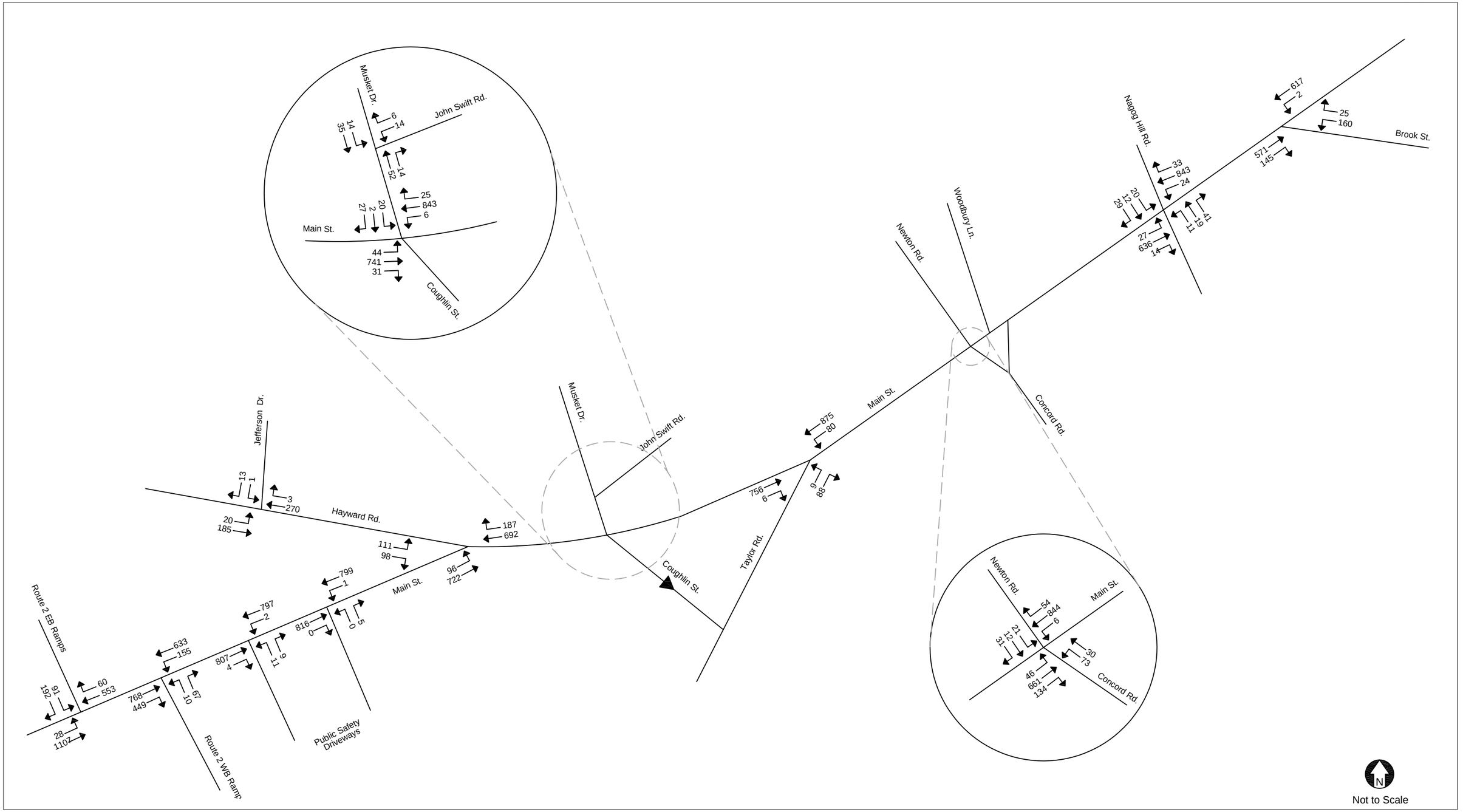


Figure 4. Existing Conditions (2007) Turning Movement Volumes, p.m. Peak Hour (4:45-5:45 p.m.)

Table 4. Existing Conditions (2007) Level of Service Summary, a.m. Peak Hour

Intersection	LOS	Delay (seconds)	V/C Ratio	95th Percentile Queue (feet)
Unsignalized Intersections				
Hayward Road/Main Street				
Hayward EB left/right	F	>50.0	>1.0	308
Main NB left/thru	A	1.9	0.07	6
Main SB thru	A	0.0	0.30	0
Main SB right	A	0.0	0.10	0
Hayward Road/Jefferson Drive				
Hayward EB left/thru	A	1.3	0.03	2
Hayward WB thru/right	A	0.0	0.15	0
Jefferson SB left/right	B	10.3	0.07	5
Musket Drive/John Swift Road				
Musket EB left/thru	A	1.3	0.01	1
Musket WB thru/right	A	0.0	0.02	0
John Swift SB left/right	A	9.1	0.05	4
Route 2 Eastbound Ramps/Main Street				
Route 2 Eastbound Ramps EB left	F	>50.0	>1.0	977
Route 2 Eastbound Ramps EB right	F	>50.0	>1.0	977
Main NB left/thru	A	0.7	0.03	2
Main SB thru/right	A	0.0	0.30	0
Route 2 Westbound Ramps/Main Street				
Route 2 Westbound Ramps WB left	D	27.7	0.19	18
Route 2 Westbound Ramps WB right	D	27.7	0.19	18
Main NB thru/right	A	0.0	0.65	0
Main SB left	B	10.4	0.11	9
Main SB thru	A	0.0	0.29	0
Public Safety South Driveway/Main Street				
Public Safety South WB left/right	C	23.5	0.09	8
Main NB thru/right	A	0.0	0.47	0
Main SB left/thru	A	0.5	0.02	1
Public Safety North Driveway/Main Street				
Public Safety North WB left/thru	C	17.7	0.05	4
Main NB thru/right	A	0.0	0.45	0
Main SB left/thru	A	0.3	0.01	1
Musket Drive/Coughlin Road/Main Street				
Musket Drive EB left/thru/right	E	45.8	0.56	75
Main NB left/thru/right	A	0.7	0.03	2
Main SB left/thru/right	A	0.3	0.01	1

Intersection	LOS	Delay (seconds)	V/C Ratio	95th Percentile Queue (feet)
Taylor Road/Main Street				
Taylor WB left/right	D	30.9	0.45	55
Main NB thru/right	A	0.0	0.48	0
Main SB left/thru	A	3.6	0.14	13
Newtown Road/Concord Road/Main Street				
Newtown EB left/thru/right	F	>50.0	0.74	114
Concord WB left/thru	F	>50.0	>1.0	162
Main NB left/thru/right	A	1.0	0.04	3
Main SB left/thru/right	A	0.3	0.01	1
Nagog Hill Road/Main Street				
Nagog Hill EB left/thru/right	F	>50.0	0.75	113
Nagog Hill WB left/thru/right	D	25.9	0.33	35
Main NB left/thru/right	A	0.7	0.03	2
Main SB left/thru	A	0.7	0.03	2
Main SB right	A	0.0	0.01	0
Brook Street/Main Street				
Brook WB left	E	45.1	0.56	74
Brook WB right	B	12.7	0.02	1
Main NB thru/right	A	0.0	0.44	0
Main SB left/thru	A	0.1	0.00	0

Table 5. Existing Conditions (2007) Level of Service Summary, p.m. Peak Hour

Intersection	LOS	Delay (seconds)	V/C Ratio	95th Percentile Queue (feet)
Unsignalized Intersections				
Hayward Road/Main Street				
Hayward EB left/right	F	>50.0	>1.0	540
Main NB left/thru	A	4.9	0.18	16
Main SB thru	A	0.0	0.46	0
Main SB right	A	0.0	0.13	0
Hayward Road/Jefferson Drive				
Hayward EB left/thru	A	1.6	0.04	3
Hayward WB thru/right	A	0.0	0.20	0
Jefferson SB left/right	B	10.6	0.03	2
Musket Drive/John Swift Road				
Musket EB left/thru	A	3.3	0.02	1
Musket WB thru/right	A	0.0	0.05	0
John Swift SB left/right	A	9.4	0.04	3
Route 2 Eastbound Ramps/Main Street				
Route 2 Eastbound Ramps EB left	F	>50.0	>1.0	559
Route 2 Eastbound Ramps EB right	F	>50.0	>1.0	559
Main NB left/thru	A	1.5	0.04	3
Main SB thru/right	A	0.0	0.41	0
Route 2 Westbound Ramps/Main Street				
Route 2 Westbound Ramps WB left	F	>50.0	0.50	62
Route 2 Westbound Ramps WB right	F	>50.0	0.50	62
Main NB thru/right	A	0.0	0.78	0
Main SB left	B	11.6	0.27	27
Main SB thru	A	0.0	0.43	0
Public Safety South Driveway/Main Street				
Public Safety South WB left/right	E	49.2	0.32	32
Main NB thru/right	A	0.0	0.51	0
Main SB left/thru	A	0.1	0.00	0
Public Safety North Driveway/Main Street				
Public Safety North WB left/thru	C	15.9	0.06	5
Main NB thru/right	A	0.0	0.52	0
Main SB left/thru	A	0.1	0.00	0
Musket Drive/Coughlin Road/Main Street				
Musket Drive EB left/thru/right	F	>50.0	0.77	97
Main NB left/thru/right	A	2.6	0.09	8
Main SB left/thru/right	A	0.6	0.02	1
Taylor Road/Main Street				
Taylor WB left/right	E	41.4	0.56	75
Main NB thru/right	A	0.0	0.49	0
Main SB left/thru	A	3.7	0.13	11

Intersection	LOS	Delay (seconds)	V/C Ratio	95th Percentile Queue (feet)
Newtown Road/Concord Road/Main Street				
Newtown EB left/thru/right	F	>50.0	>1.0	246
Concord WB left/thru	F	>50.0	>1.0	Error*
Main NB left/thru/right	A	2.6	0.09	8
Main SB left/thru/right	A	0.4	0.01	1
Nagog Hill Road/Main Street				
Nagog Hill EB left/thru/right	F	>50.0	>1.0	144
Nagog Hill WB left/thru/right	F	>50.0	0.93	137
Main NB left/thru/right	A	1.3	0.05	4
Main SB left/thru	A	1.2	0.04	3
Main SB right	A	0.0	0.03	0
Brook Street/Main Street				
Brook WB left	F	>50.0	>1.0	450
Brook WB right	B	14.3	0.09	8
Main NB thru/right	A	0.0	0.49	0
Main SB left/thru	A	0.1	0.00	0

*'Error' = queue is theoretically infinite.

Under existing peak-hour conditions, traffic along Main Street (Route 27) is continuous, with limited gaps for vehicles on the minor streets to cross or enter Main Street—resulting in long queues and unsafe driving. The following intersection approaches operate below LOS D under Existing Conditions:

Hayward Road/Main Street. During the a.m. and p.m. peak hours, the Hayward Road eastbound shared left-turn/right-turn travel lane operates at LOS F. The queues on Hayward Road extend for over 300 feet (12 vehicles) in the a.m. peak hour and over 500 feet in the p.m. peak hour. As a point of reference, the driveway for 14 Hayward Road is located approximately 500 feet from the intersection of Hayward Road and Main Street.

Route 2 Eastbound Ramps/Main Street. The Route 2 Eastbound Off-ramp exclusive left-turn lane and exclusive right-turn lane operate at LOS F during the a.m. and p.m. peak hour. The queue on the ramp extends approximately 975 feet (39 vehicles) in the a.m. peak hour and nearly 600 feet (24 vehicles) in the p.m. peak hour. A queue of 975 feet extends onto the mainline of Route 2 Eastbound, while a queue of 600 feet a little more than halfway down the ramp.

Route 2 Westbound Ramps/Main Street. During the p.m. peak hour, the Route 2 Westbound Off-ramp exclusive left-turn lane and exclusive right-turn lane both operate at LOS F.

Public Safety South Driveway/Main Street. The Public Safety South Driveway westbound shared left-turn/right-turn lane operates at LOS E during the p.m. peak hour.

Musket Drive/Coughlin Road/Main Street. The Musket Drive eastbound approach shared left/through/right lane operates at LOS E during the a.m. peak hour and LOS F during the p.m. peak hour.

Taylor Road/Main Street. During the p.m. peak hour, the Taylor Road westbound approach shared left-turn/right-turn lane operates at LOS E.

Newtown Road/Concord Road/Main Street. During the a.m. and p.m. peak hours, the Newtown Road eastbound approach shared left/through/right lane and the Concord Road westbound approach shared left/through/right lane both operate at LOS F. During the a.m. peak hour, the queues on Newtown and Concord roads are manageable, 4 to 6 vehicles; however, in the p.m. peak hour, the queue on Newtown Road extends approximately 250 feet, or 10 vehicles. The queue on Concord Road in the p.m. peak hour is so long that software used for the calculations views it as theoretically infinite.

Nagog Hill Road/Main Street. The Nagog Hill Road eastbound shared left/through/right lane operates at LOS F during the a.m. and p.m. peak hours. During the p.m. peak hour, the Nagog Hill westbound approach shared left/through/right lane operates at LOS F.

Brook Street/Main Street. During the a.m. and p.m. peak hours, the Brook Street westbound left-turn lane operates at LOS E and LOS F, respectively. The queue on Brook Street in the p.m. peak hour is approximately 450 feet, or 18 vehicles.

Crash History

The study team obtained motor vehicle crash data from the Acton Police Department (APD) for crashes occurring within the study area. The APD crash data were used instead of the Massachusetts Highway Department (MassHighway) Crash Data System, because it was determined the APD data were more accurate. The crash reports obtained were for crashes occurring between January 2002 and October 2007. **Table 6** and **Table 7** summarize the data for the study area intersections, except for the intersection of Hayward Road/Main Street, which is discussed in the following section. Crash rate worksheets are included here as **Appendix C.**

Table 6. Crash History, 2002–07

Scenario	Main Street/ Route 2 EB Ramps	Main Street/ Route 2 WB Ramps	Main Street/ Public Safety Driveways	Main Street/ Coughlin Road/ Musket Drive	Main Street/ Taylor Road
Year					
2002	6	3	2	2	1
2003	6	1	3	0	3
2004	7	1	2	0	5
2005	8	2	2	1	2
2006	6	3	3	5	1
2007	3	0	0	0	1
Type					
Single Vehicle Crash	0	0	0	1	1
Angle	9	2	3	0	4
Rear-end	24	8	9	7	7
Head-on	0	0	0	0	0
Sideswipe	3	0	0	0	1
Unknown/Other	0	0	0	0	0
Severity					
Property Damage Only	32	7	8	6	10
Personal Injury	4	3	4	2	2
Fatality	0	0	0	0	0
Hit and Run	0	0	0	0	1
Hour of Day					
6:00–8:59 a.m.	6	0	0	1	2
9:00 a.m.–2:59 p.m.	19	6	3	3	7
3:00–5:59 p.m.	9	4	9	3	3
6:00 p.m.–5:59 a.m.	2	0	0	1	1
Day of Week					
Monday	7	1	1	1	1
Tuesday	9	2	4	0	2
Wednesday	7	0	1	3	5
Thursday	5	3	3	0	1
Friday	6	3	2	2	4
Saturday	1	1	1	2	0
Sunday	1	0	0	0	0
Summary					
Total	**36**	**10**	**12**	**8**	**13**
Crash Rate	**0.94**	**0.32**	**0.48**	**0.27**	**0.44**
District Average			0.79		
Statewide Average			0.66		

Table 7. Crash History, 2002–07

Scenario	Main Street/ Newtown Road/ Concord Road	Main Street/ Nagog Hill Road	Main Street/ Brook Street	On Main Street
Year				
2002	1	1	4	9
2003	5	4	5	11
2004	5	2	5	12
2005	7	2	4	13
2006	3	3	4	6
2007	3	0	0	3
Type				
Single Vehicle Crash	1	1	7	13
Angle	18	6	11	6
Rear-end	4	5	1	27
Head-on	0	0	1	1
Sideswipe	1	0	2	6
Unknown/Other	0	0	0	1
Severity				
Property Damage Only	18	7	17	42
Personal Injury	6	5	4	12
Fatality	0	0	0	0
Hit and Run	0	0	1	0
Hour of Day				
6:00–8:59 a.m.	2	0	4	2
9:00 a.m.–2:59 p.m.	11	6	6	27
3:00–5:59 p.m.	8	5	5	12
6:00 p.m.–5:59 a.m.	3	1	7	13
Day of Week				
Monday	3	2	3	10
Tuesday	4	2	5	8
Wednesday	4	1	3	7
Thursday	5	1	1	11
Friday	2	4	4	8
Saturday	5	1	2	8
Sunday	1	1	4	2
Summary				
Total	**24**	**12**	**22**	**54**
Crash Rate	**0.77**	**0.44**	**0.89**	**—**
District Average		0.79		
Statewide Average		0.66		

As shown, many crashes occurred at the study area intersections between 2002 and 2007. Of these, no fatalities were reported. Most of the crashes occurring along Main Street were not reported at an intersection. Of these 54 crashes that occurred along Main Street, 27 crashes (50%) were reported as rear-end

crashes. Of all the study area intersections, the intersection of Main Street/Route 2 Eastbound Ramps had the most crashes (36). At this intersection, 24 crashes (67%) were rear-end crashes, with most resulting in property damage only. Out of all the crashes that occurred along Main Street and at the study area intersections, the most commonly reported were rear-end crashes, resulting in property damage only, and occurred between 9:00 a.m. and 3:00 p.m.

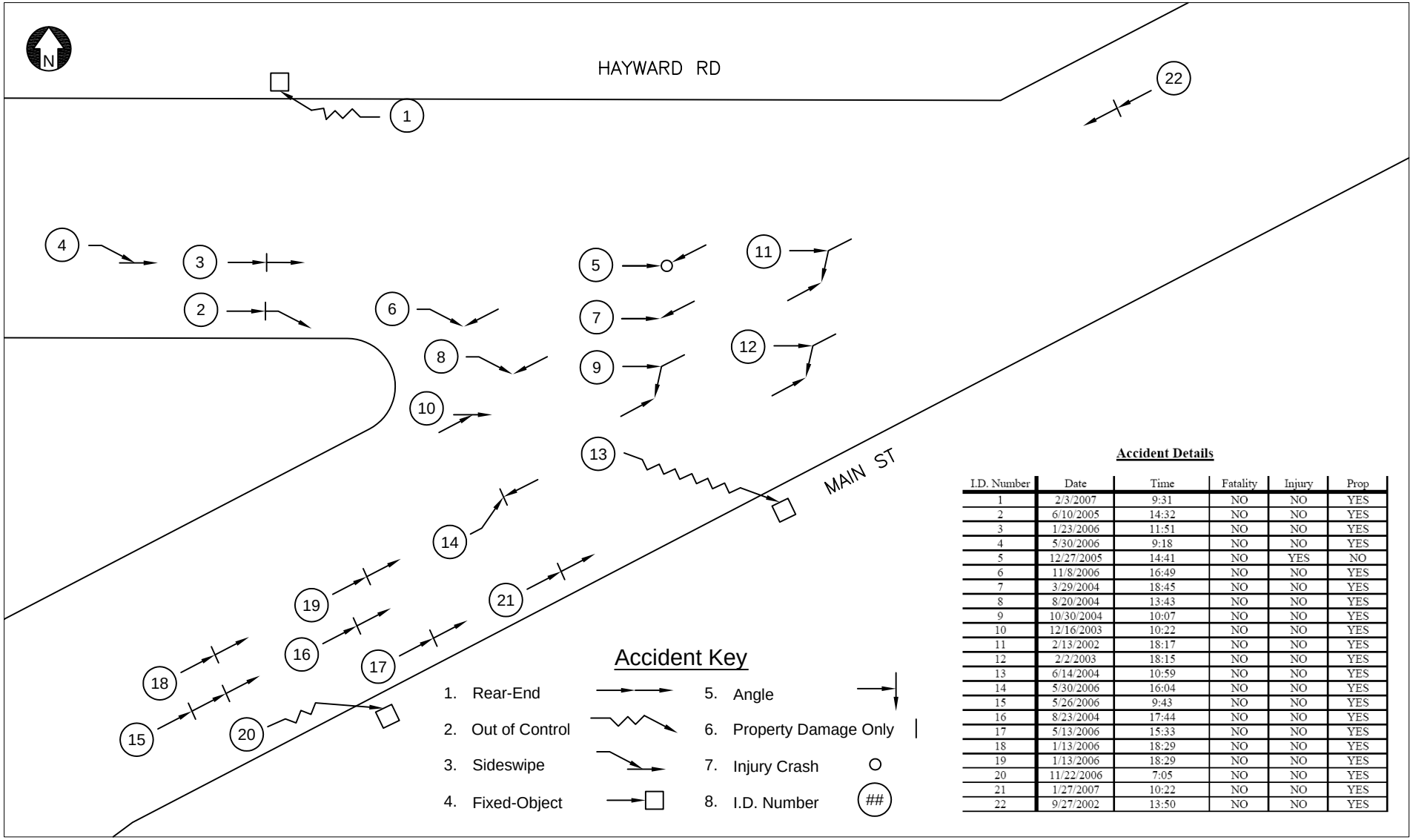
Crash rates are determined for an intersection based on the number of crashes per million vehicles entering the intersection. Calculations for the crash rates were based on crashes occurring between 2002 and 2006, since the 2007 crash data did not encompass a complete year. The average crash rates at the analyzed intersections are mostly below MassHighway's statewide and District 3 averages, except for Main Street/Route 2 EB Ramps, Main Street/Newtown Road/Concord Road, and Main Street/Brook Street. The intersection of Main Street/Route 2 Eastbound Ramps has the highest crash rate: 0.94. Main Street/Brook Street has a crash rate of 0.89 and Main Street/Newtown Road/Concord Road a crash rate of 0.77.

Hayward Road/Main Street

Crashes that occurred at the intersection of Hayward Road/Main Street are summarized in **Table 8.** The collision diagram is shown in **Figure 5.** Between 2002 and 2007, 21 crashes were reported at the intersection of Hayward Road/Main Street. Of these 21 crashes, 10 crashes (48%) were angle crashes, and 19 (90%) were property-damage-only crashes. The crash rate for Hayward Road/Main Street is 0.69, which is below the MassHighway District 3 average but above the statewide average.

Table 8. Hayward Road/Main Street Crash History, 2002–07

Scenario	Hayward Road/Main Street
Year	
2002	2
2003	2
2004	5
2005	2
2006	8
2007	2
Type	
Single Vehicle Crash	3
Angle	10
Rear-end	7
Sideswipe	1
Severity	
Property Damage Only	19
Personal Injury	1
Fatality	0
Hit and Run	1
Hour of Day	
6:00–8:59 a.m.	0
9:00 a.m.–2:59 p.m.	12
3:00–5:59 p.m.	4
6:00 p.m.–5:59 a.m.	5
Day of Week	
Monday	4
Tuesday	4
Wednesday	3
Thursday	0
Friday	5
Saturday	4
Sunday	1
Summary	
Total	**21**
Crash Rate	**0.69**
District Average	0.79
Statewide Average	0.66



Accident Details

I.D. Number	Date	Time	Fatality	Injury	Prop
1	2/3/2007	9:31	NO	NO	YES
2	6/10/2005	14:32	NO	NO	YES
3	1/23/2006	11:51	NO	NO	YES
4	5/30/2006	9:18	NO	NO	YES
5	12/27/2005	14:41	NO	YES	NO
6	11/8/2006	16:49	NO	NO	YES
7	3/29/2004	18:45	NO	NO	YES
8	8/20/2004	13:43	NO	NO	YES
9	10/30/2004	10:07	NO	NO	YES
10	12/16/2003	10:22	NO	NO	YES
11	2/13/2002	18:17	NO	NO	YES
12	2/2/2003	18:15	NO	NO	YES
13	6/14/2004	10:59	NO	NO	YES
14	5/30/2006	16:04	NO	NO	YES
15	5/26/2006	9:43	NO	NO	YES
16	8/23/2004	17:44	NO	NO	YES
17	5/13/2006	15:33	NO	NO	YES
18	1/13/2006	18:29	NO	NO	YES
19	1/13/2006	18:29	NO	NO	YES
20	11/22/2006	7:05	NO	NO	YES
21	1/27/2007	10:22	NO	NO	YES
22	9/27/2002	13:50	NO	NO	YES

Figure 5: Collision Diagram 2002-2007, Hayward Road/Main Street

Traffic Signal Warrant Analysis

Because the intersection met warrants in previous studies, signal warrant analysis was conducted for the Hayward Road/Main Street intersection. A signal warrant analysis is based on volume data and crash history at a location. As shown in **Table 9,** the 2003 *Manual on Uniform Traffic Control Devices* (MUTCD 2003) lists 8 warrants (see **Appendix D),** 1 or more of which must be met to justify signalization. Satisfying 1 or more warrants for signalization does not compel the installation of a traffic signal; it merely justifies doing so, should engineering judgment determine signal installation to be the appropriate course of action.

Table 9. MUTCD Signal Warrants

Warrant		Description
1.	8-hour vehicular volume	Traffic volumes for 8 hours of an average day exceed the threshold given in MUTCH 2003.
2.	4-hour vehicular volume	Traffic volumes for 4 hours of an average day exceed the threshold given in MUTCD 2003.
3.	Peak-hour vehicular volume	Traffic volumes for 1 hour of an average day exceed the threshold given in MUTCD 2003.
4.	Pedestrian volume	Pedestrian volumes exceed the threshold given in MUTCD 2003.
5.	School crossing	School children cross the major street.
6.	Coordinated signal	Ensures progressive movement in a coordinated signal system.
7.	Crash experience	Severity and frequency of crashes exceed the threshold given in MUTCD 2003.
8.	Roadway network	Encourages concentration and organization of traffic flow on a roadway network.

The study team evaluated 2 warrants under Existing Conditions at the intersection of Hayward Road/Main Street:

- Warrant 1: 8-hour vehicular volume; and
- Warrant 2: 4-hour vehicular volume.

Warrant 1, 8-hour Vehicular Volume[1]

The 8-hour vehicular volume signal warrant conditions is intended to be applied when the volume of intersection traffic is high and/or the traffic volume on a major street is so heavy that traffic on a minor intersecting street suffers excessive delay or conflict in entering or crossing the major street.

[1] Source: Section 4C.02 Table 4C-1, *Manual on Uniform Traffic Control Devices,* 2003 (MUTCD 2003).

Warrant 1 is used when continuous traffic volume is the principal reason to consider installing a traffic control signal.

For Warrant 1 to be satisfied, the total traffic on the major street with 1 travel lane in each direction would exceed 750 vehicles per hour, and the traffic on the higher approach on the minor street with 1 travel lane would exceed 75 vehicles per hour for each of 8 hours of an average day. This is considered the interruption of continuous traffic due to excessive delay condition.

Warrant 2, 4-hour Vehicular Volume[2]

The 4-hour vehicular volume signal warrant condition is intended to be applied when the volume of intersection traffic is the principal reason to consider installing a traffic control signal.

For Warrant 2 to be satisfied, the total traffic on the major street with 1 travel lane in each direction and the traffic on the higher approach on the minor street with 1 travel lane would exceed the plotted line in Figure 4C-1 of MUTCD 2003 for each of 4 hours of an average day.

The existing traffic volume data and warrant analysis results for the Hayward Road/Main Street intersection are shown in **Table 10,** based on the traffic volumes collected in October 2007. The intersection of Hayward Road/Main Street meets Warrants 1 and 2 under 2007 Existing Conditions.

Table 10. Warrant Analysis

Begin Time	Major Street; Total Both Approaches	Minor Street; Higher Volume Approach	Warrant 1	Warrant 2
7:00 a.m.	1,161	251	YES	—
8:00 a.m.	1,256	190	YES	—
12:00 noon	1,170	140	YES	—
2:00 p.m.	1,182	228	YES	—
3:00 p.m.	1,384	199	YES	YES
4:00 p.m.	1,423	203	YES	YES
5:00 p.m.	1,598	234	YES	YES
6:00 p.m.	1,300	195	YES	YES
			Warrant Satisfied	**Warrant Satisfied**

[2] Source: Section 4C.03 Figure 4C-1, MUTCD 2003.

Future Conditions

This section presents a description and evaluation of future traffic conditions.

Background Growth

To account for future developments and changes in demographics, auto usage, and ownership, the study team applied a background growth rate. A review of traffic volumes in the area, including the previous intersection and Main Street studies as well as the Town's *Master Plan,* indicates no trend that shows a growth in traffic volumes over the past 20 years. For the purpose of a worst-case analysis, the study team and Town agreed to apply a general background growth of 1% per year, compounded annually. For comparison purposes and as a sensitivity marker, all analysis was also performed with a decline in volumes of 20% to indicate the conditions under off-peak conditions and/or if there were a decline in traffic volumes in the future. These analyses results are not summarized further in the text but are included in **Appendix B.**

2017 Traffic Operations

The 2017 Future Conditions analysis uses the same methodology described in the Existing Conditions analysis. Future 2017 traffic volumes are shown in **Figure 6** and **Figure 7** for the a.m. and p.m. peak hours, respectively. The resulting intersection operations results are shown in **Table 11** and **Table 12.** Complete Synchro reports are provided in **Appendix B.**

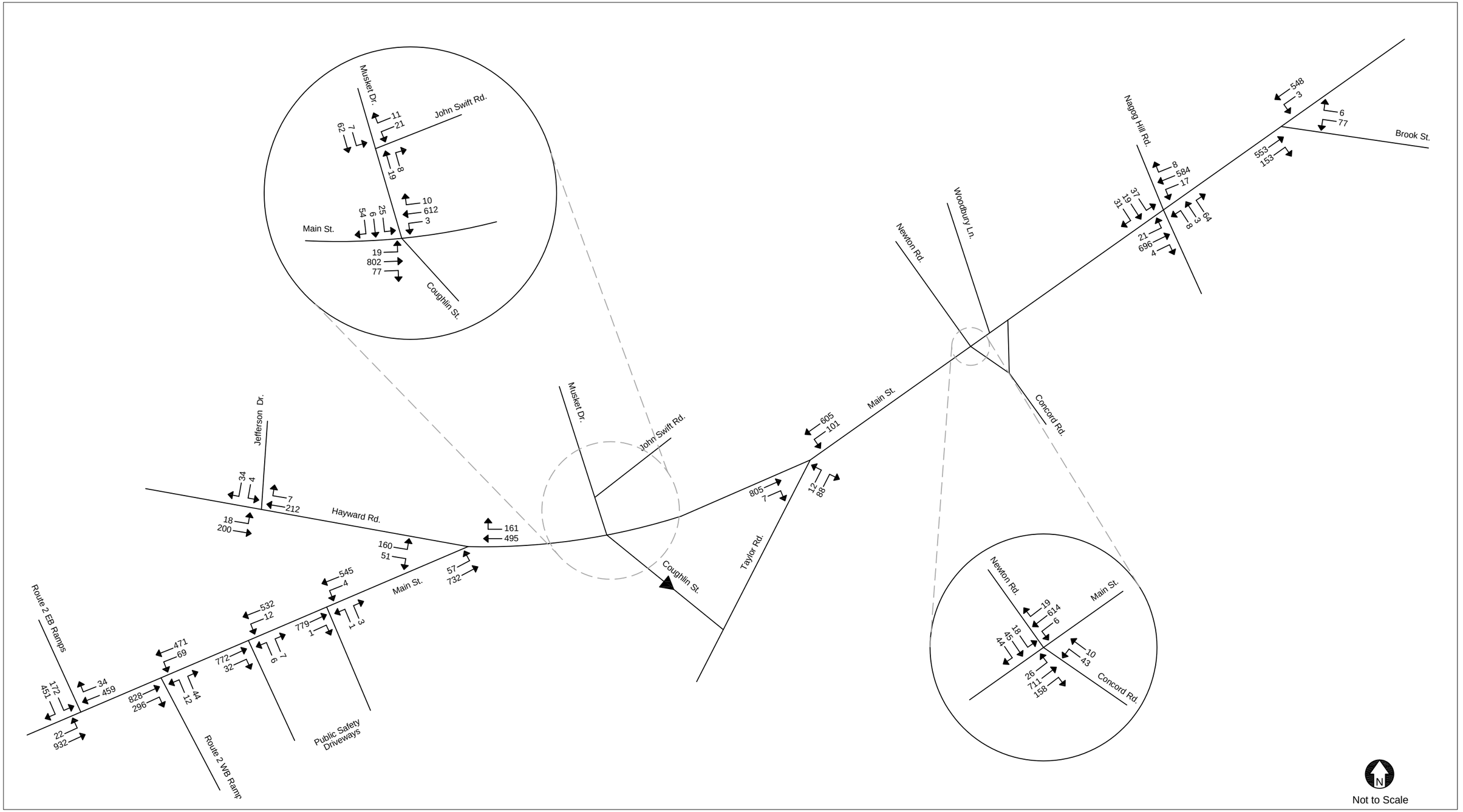


Figure 6. Future Conditions (2017) Turning Movement Volumes, a.m. Peak Hour

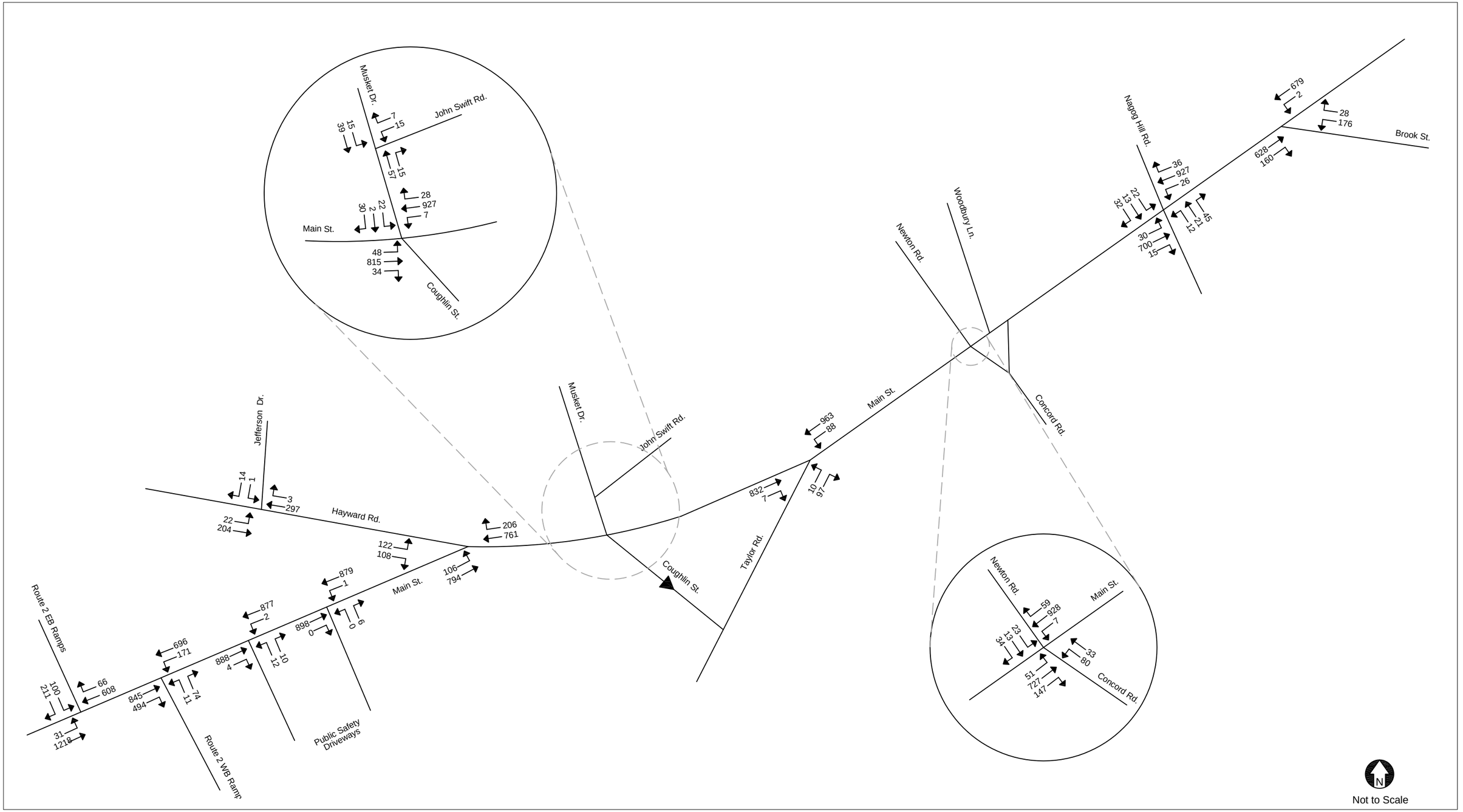


Figure 7. Future Conditions (2017) Turning Movement Volumes, p.m. Peak Hour

Table 11. Future Conditions (2017) Level of Service Summary, a.m. Peak Hour

Intersection	LOS	Delay (seconds)	V/C Ratio	95th Percentile Queue (feet)
Unsignalized Intersections				
Hayward Road/Main Street				
Hayward EB left/right	F	>50.0	>1.0	441
Main NB left/thru	A	2.2	0.09	7
Main SB thru	A	0.0	0.33	0
Main SB right	A	0.0	0.11	0
Hayward Road/Jefferson Drive				
Hayward EB left/thru	A	1.4	0.03	2
Hayward WB thru/right	A	0.0	0.16	0
Jefferson SB left/right	B	10.6	0.08	6
Musket Drive/John Swift Road				
Musket EB left/thru	A	1.3	0.01	1
Musket WB thru/right	A	0.0	0.02	0
John Swift SB left/right	A	9.2	0.05	4
Route 2 Eastbound Ramps/Main Street				
Route 2 Eastbound Ramps EB left	F	>50.0	>1.0	1,412
Route 2 Eastbound Ramps EB right	F	>50.0	>1.0	1,412
Main NB left/thru	A	0.9	0.03	2
Main SB thru/right	A	0.0	0.33	0
Route 2 Westbound Ramps/Main Street				
Route 2 Westbound Ramps WB left	D	34.9	0.27	27
Route 2 Westbound Ramps WB right	D	34.9	0.27	27
Main NB thru/right	A	0.0	0.72	0
Main SB left	B	10.9	0.13	11
Main SB thru	A	0.0	0.32	0
Public Safety South Driveway/Main Street				
Public Safety South WB left/right	D	27.8	0.12	10
Main NB thru/right	A	0.0	0.51	0
Main SB left/thru	A	0.6	0.02	2
Public Safety North Driveway/Main Street				
Public Safety North WB left/thru	C	19.8	0.07	5
Main NB thru/right	A	0.0	0.50	0
Main SB left/thru	A	0.3	0.01	1
Musket Drive/Coughlin Road/Main Street				
Musket Drive EB left/thru/right	F	>50.0	0.76	119
Main NB left/thru/right	A	0.9	0.03	2
Main SB left/thru/right	A	0.3	0.01	1

Intersection	LOS	Delay (seconds)	V/C Ratio	95th Percentile Queue (feet)
Taylor Road/Main Street				
Taylor WB left/right	E	45.3	0.60	84
Main NB thru/right	A	0.0	0.52	0
Main SB left/thru	A	4.2	0.17	15
Newtown Road/Concord Road/Main Street				
Newtown EB left/thru/right	F	>50.0	>1.0	179
Concord WB left/thru	F	>50.0	>1.0	229
Main NB left/thru/right	A	1.2	0.04	3
Main SB left/thru/right	A	0.3	0.01	1
Nagog Hill Road/Main Street				
Nagog Hill EB left/thru/right	F	>50.0	>1.0	177
Nagog Hill WB left/thru/right	E	35.4	0.44	52
Main NB left/thru/right	A	0.8	0.03	2
Main SB left/thru	A	0.8	0.03	2
Main SB right	A	0.0	0.01	0
Brook Street/Main Street				
Brook WB left	F	>50.0	0.73	112
Brook WB right	B	13.5	0.02	2
Main NB thru/right	A	0.0	0.49	0
Main SB left/thru	A	0.1	0.01	0

Note: Shaded cells indicate a worsening of LOS from Existing Conditions.

Table 12. Future Conditions (2017) Level of Service Summary, p.m. Peak Hour

Intersection	LOS	Delay (seconds)	V/C Ratio	95th Percentile Queue (feet)
Unsignalized Intersections				
Hayward Road/Main Street				
Hayward EB left/right	F	>50.0	>1.0	Error*
Main NB left/thru	A	5.5	0.21	20
Main SB thru	A	0.0	0.50	0
Main SB right	A	0.0	0.14	0
Hayward Road/Jefferson Drive				
Hayward EB left/thru	A	1.7	0.04	3
Hayward WB thru/right	A	0.0	0.22	0
Jefferson SB left/right	B	10.9	0.03	3
Musket Drive/John Swift Road				
Musket EB left/thru	A	3.3	0.02	2
Musket WB thru/right	A	0.0	0.05	0
John Swift SB left/right	A	9.5	0.04	3
Route 2 Eastbound Ramps/Main Street				
Route 2 Eastbound Ramps EB left	F	>50.0	>1.0	783
Route 2 Eastbound Ramps EB right	F	>50.0	>1.0	783
Main NB left/thru	A	2.2	0.05	4
Main SB thru/right	A	0.0	0.45	0
Route 2 Westbound Ramps/Main Street				
Route 2 Westbound Ramps WB left	F	>50.0	0.81	125
Route 2 Westbound Ramps WB right	F	>50.0	0.81	125
Main NB thru/right	A	0.0	0.86	0
Main SB left	B	12.6	0.31	34
Main SB thru	A	0.0	0.48	0
Public Safety South Driveway/Main Street				
Public Safety South WB left/right	F	>50.0	0.45	48
Main NB thru/right	A	0.0	0.57	0
Main SB left/thru	A	0.1	0.00	0
Public Safety North Driveway/Main Street				
Public Safety North WB left/thru	C	17.4	0.07	6
Main NB thru/right	A	0.0	0.57	0
Main SB left/thru	A	0.1	0.00	0
Musket Drive/Coughlin Road/Main Street				
Musket Drive EB left/thru/right	F	>50.0	>1.0	146
Main NB left/thru/right	A	3.5	0.11	9
Main SB left/thru/right	A	0.8	0.02	2
Taylor Road/Main Street				
Taylor WB left/right	F	>50.0	0.76	122
Main NB thru/right	A	0.0	0.54	0
Main SB left/thru	A	5.0	0.15	13

Intersection	LOS	Delay (seconds)	V/C Ratio	95th Percentile Queue (feet)
Newtown Road/Concord Road/Main Street				
Newtown EB left/thru/right	F	>50.0	>1.0	Error*
Concord WB left/thru	F	>50.0	>1.0	Error*
Main NB left/thru/right	A	3.4	0.11	9
Main SB left/thru/right	A	0.5	0.01	1
Nagog Hill Road/Main Street				
Nagog Hill EB left/thru/right	F	>50.0	>1.0	216
Nagog Hill WB left/thru/right	F	>50.0	>1.0	211
Main NB left/thru/right	A	1.6	0.06	5
Main SB left/thru	A	1.5	0.05	4
Main SB right	A	0.0	0.04	0
Brook Street/Main Street				
Brook WB left	F	>50.0	>1.0	Error*
Brook WB right	C	17.1	0.13	11
Main NB thru/right	A	0.0	0.54	0
Main SB left/thru	A	0.1	0.00	0

Note: Shaded cells indicate a worsening of LOS from Existing Conditions.
*Error: Queue is theoretically infinite.

Alternative Analysis

The study team developed 5 options for improving the intersection of Hayward Road/Main Street and conducted analyses to determine whether each would improve the intersection. The alternatives, described in the following sections, consist of:

- Option 1: Widening to Accommodate Current Movements;
- Option 2: Widening Plus Left-turn Pocket;
- Option 3: Widening Plus Channelization;
- Option 4: Signalized Intersection; and
- Option 5: Modern Roundabout.

It should be noted that all alternatives include provisions for moving the sidewalks back 3 feet to install a grass strip between each sidewalk and the roadway, providing a buffer for pedestrians.

Option 1: Widening to Accommodate Current Movements

The first option for the intersection is to widen the Hayward Road eastbound approach to provide 2 lanes on Hayward Road, with enough storage for approximately 4 vehicles in the right-turn lane.

This option would also widen Main Street slightly to allow a vehicle to pass another vehicle waiting to turn left from Main Street northbound onto Hayward Road. Option 1 is shown graphically in **Figure 8.**

This option would widen the radius so that a large truck (i.e., tractor-trailer) can turn to and from Hayward Road without encroaching on the opposing lanes of traffic, as trucks do today. This option does not change the existing traffic control; traffic from Hayward Road would continue to be controlled by a STOP sign on Hayward Road.

The cost to construct Option 1 would be approximately $150,000, which includes minor modifications to the drainage, box widening on both Main Street and Hayward Road as shown in **Figure 8,** and new sidewalks with a grass strip between the edge of the roadway and the sidewalk. An order-of-magnitude cost estimate includes major items such as bituminous concrete pavement, sidewalks, granite curb or sloped edging, drainage, and traffic signal control, if applicable. It also includes a 25% contingency for other items that have not been detailed at this level of design. The cost estimate will be refined in the final design process.

Option 2: Widening Plus Left-turn Pocket

Option 2, shown in **Figure 9,** includes the same widening on Hayward Road as Option 1, but it also includes widening on Main Street to accommodate a left-turn pocket on the Main Street northbound approach. The left-turn pocket on Main Street provides a measure of safety for vehicles waiting to turn left, but it may also allow speeding vehicles more ease in passing a stopped vehicle on the right, thus encouraging vehicles to increase speed.

The cost to construct Option 2 would be approximately $330,000, which includes box widening to construct a left-turn lane on Main Street northbound, and widening of Hayward Road to accommodate truck turns. New sidewalks are also included in the cost. The order-of-magnitude cost estimate will be refined in the final design process.

Option 3: Widening Plus Channelization

Option 3 changes the geometry of the intersection significantly, introducing a larger island, which benefits pedestrians by providing a refuge in the middle of the long Hayward Road crossing. Option 3 is shown graphically in **Figure 10.** This option also relocates the Hayward Road approach so that it is aligned closer to 90 degrees to Main Street, improving sight distance. This option could include a pedestrian signal at Musket Drive and the elimination of the crosswalk across Main Street at Hayward Road.

The cost to construct Option 3 would be approximately $320,000, which includes construction of a new channelizing island on Hayward Road, widening to accommodate a left-turn lane on Main Street northbound and on Hayward Road to accommodate truck turns. New sidewalks are also included in the cost. The order-of-magnitude cost estimate will be refined in the final design process.

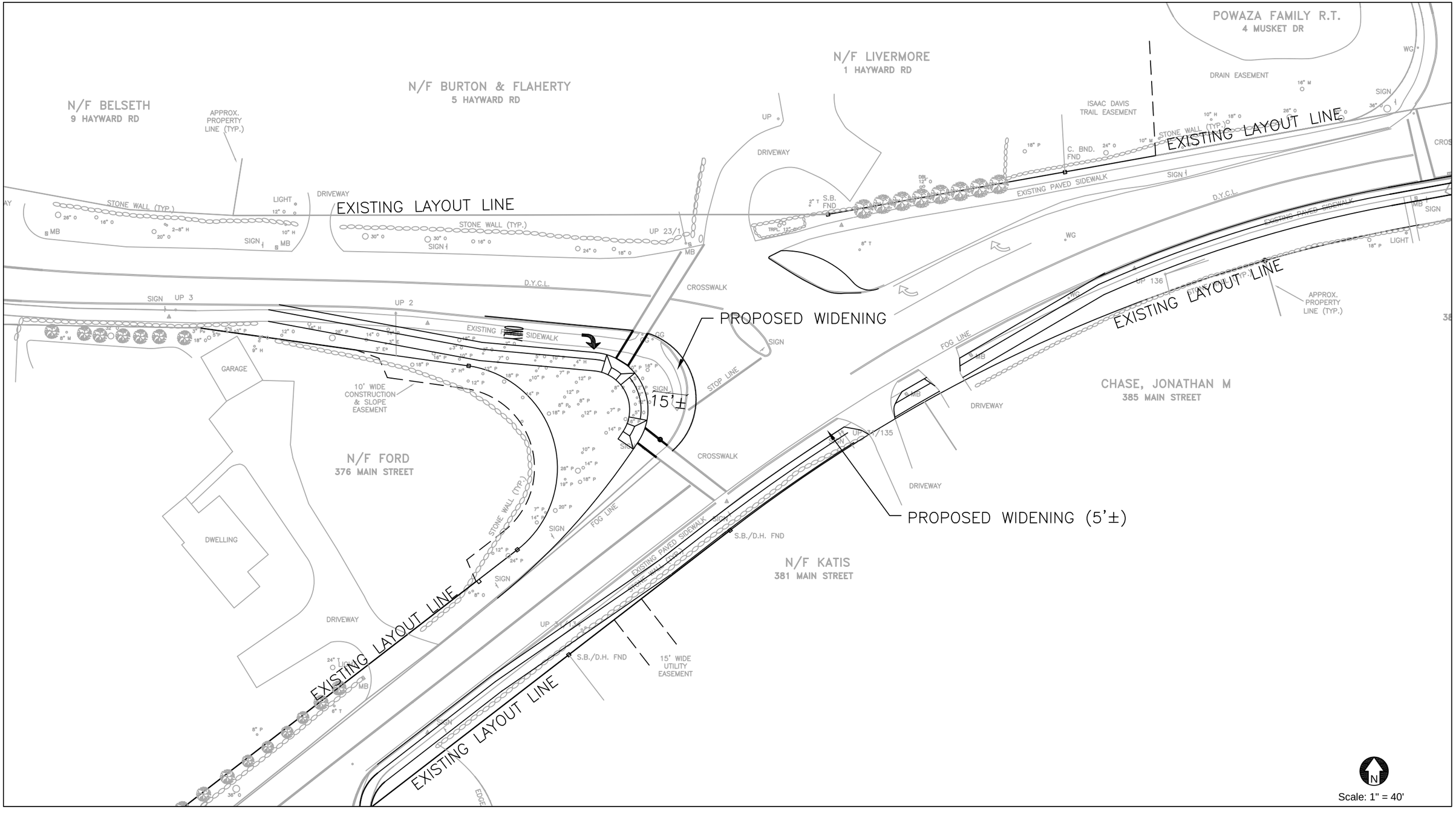


Figure 8. Option 1: Widening to Accommodate Current Movements

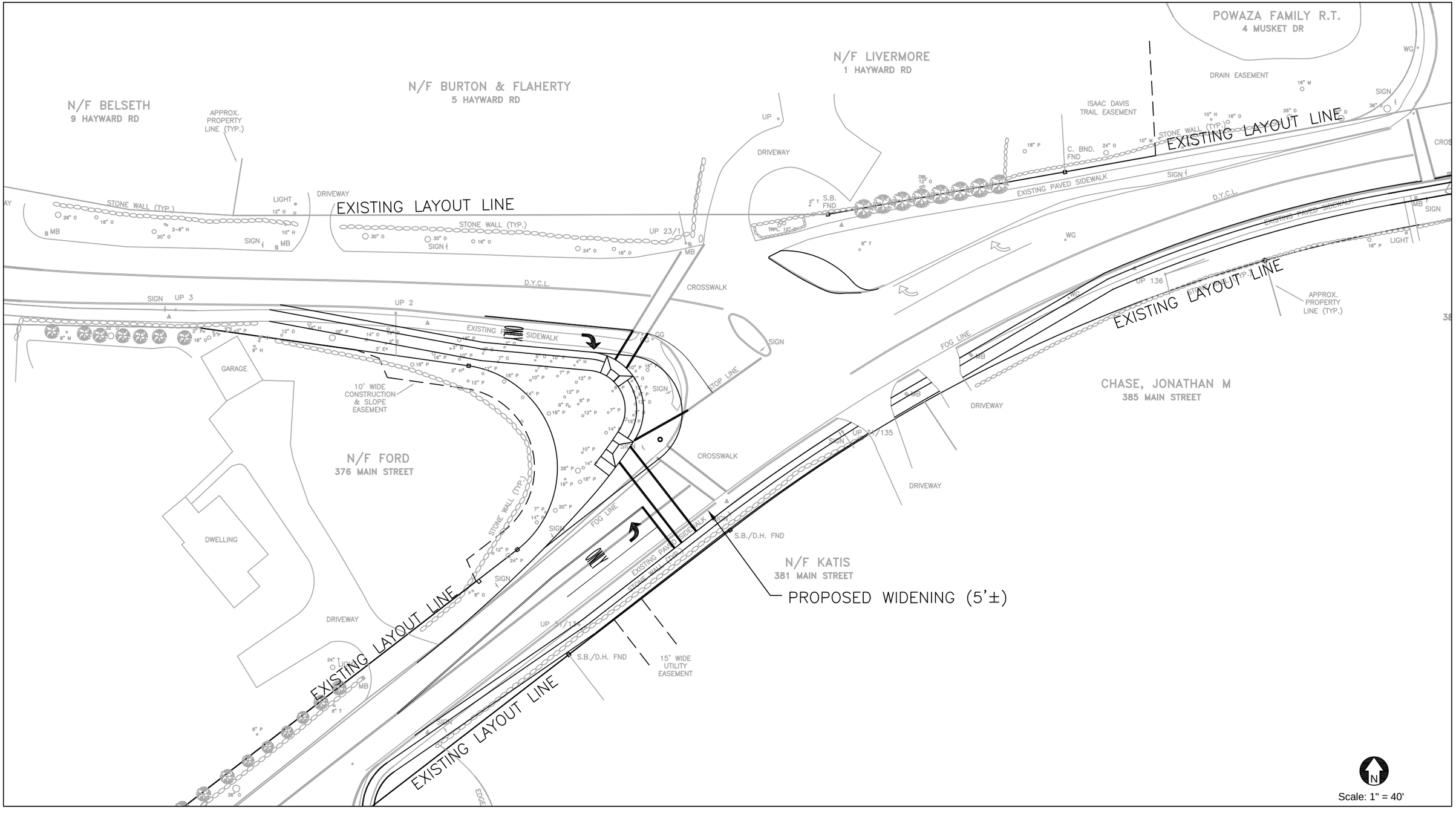


Figure 9. Option 2: Widening Plus Left-turn Pocket

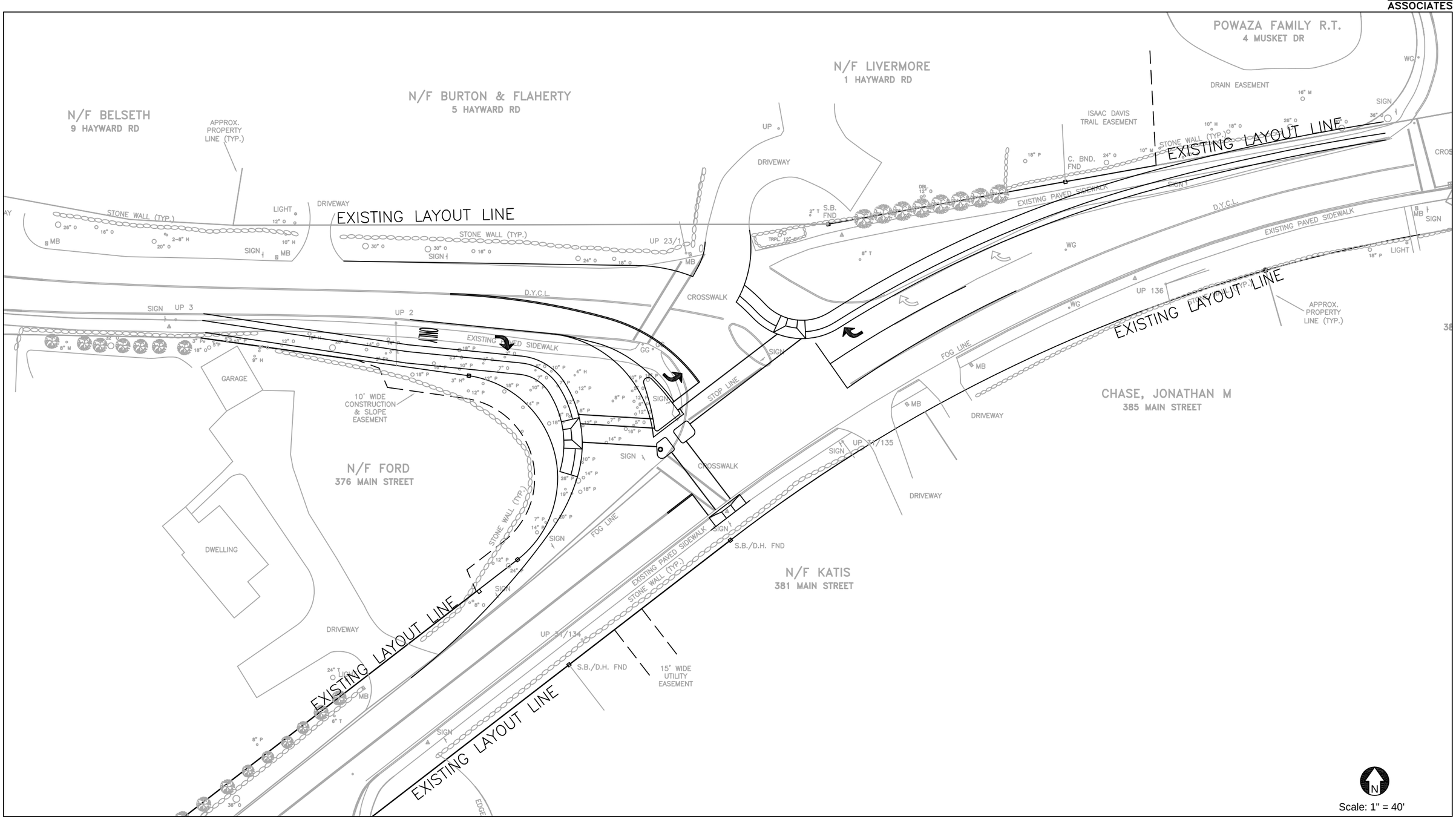


Figure 10. Option 3: Widening Plus Channelization

Table 13 shows the future intersection LOS for the a.m. and p.m. peak hour for Options 1-3 at Hayward Road/Main Street. The traffic control measures in these 3 options are the same. They provide no benefit in terms of capacity at the intersection. Complete Synchro reports are provided in **Appendix B.**

Table 13. Future Conditions (2017) Level of Service Summary, Geometric Changes

Intersection	LOS	Delay (seconds)	V/C Ratio	95th Percentile Queue (feet)
a.m. Peak Hour				
Hayward Road/Main Street				
Hayward EB left	F	>50.0	>1.0	439
Hayward EB right	F	>50.0	>1.0	439
Main NB left	A	9.8	0.09	7
Main NB thru	A	0.0	0.47	0
Main SB thru	A	0.0	0.33	0
Main SB right	A	0.0	0.11	0
p.m. Peak Hour				
Hayward Road/Main Street				
Hayward EB left	F	>50.0	>1.0	Error*
Hayward EB right	F	>50.0	>1.0	Error*
Main NB left	B	12.5	0.21	20
Main NB thru	A	0.0	0.51	0
Main SB thru	A	0.0	0.50	0
Main SB right	A	0.0	0.14	0

*'Error = Queue is theoretically infinite.

Option 4: Signalized Intersection

The geometry of Option 4 is similar to that of Option 2. The difference is that Option 4 includes installing a signal at the intersection. Option 4 is shown in **Figure 11.** The signal would allow vehicles to exit Hayward Road safely at regular intervals. It could also provide a safe pedestrian crossing through an all-stop, pushbutton-activated pedestrian phase. The new signal could increase rear-end crashes. It may also promote cut-through traffic in Patriots Hill as vehicles change their routes to either avoid or use the signal. While the amount of cut-through traffic cannot be quantified, the study team expects that the new signal could draw traffic from Musket Drive onto other roads to use the signal for access to Main Street, particularly those vehicles that want to turn left. The traffic signal could also create gaps for Musket Drive, Taylor Road, and other proximate intersections, which could make their use more desirable, creating cut-through traffic through Patriots Hill to avoid the signal but take advantage of the new gaps it creates.

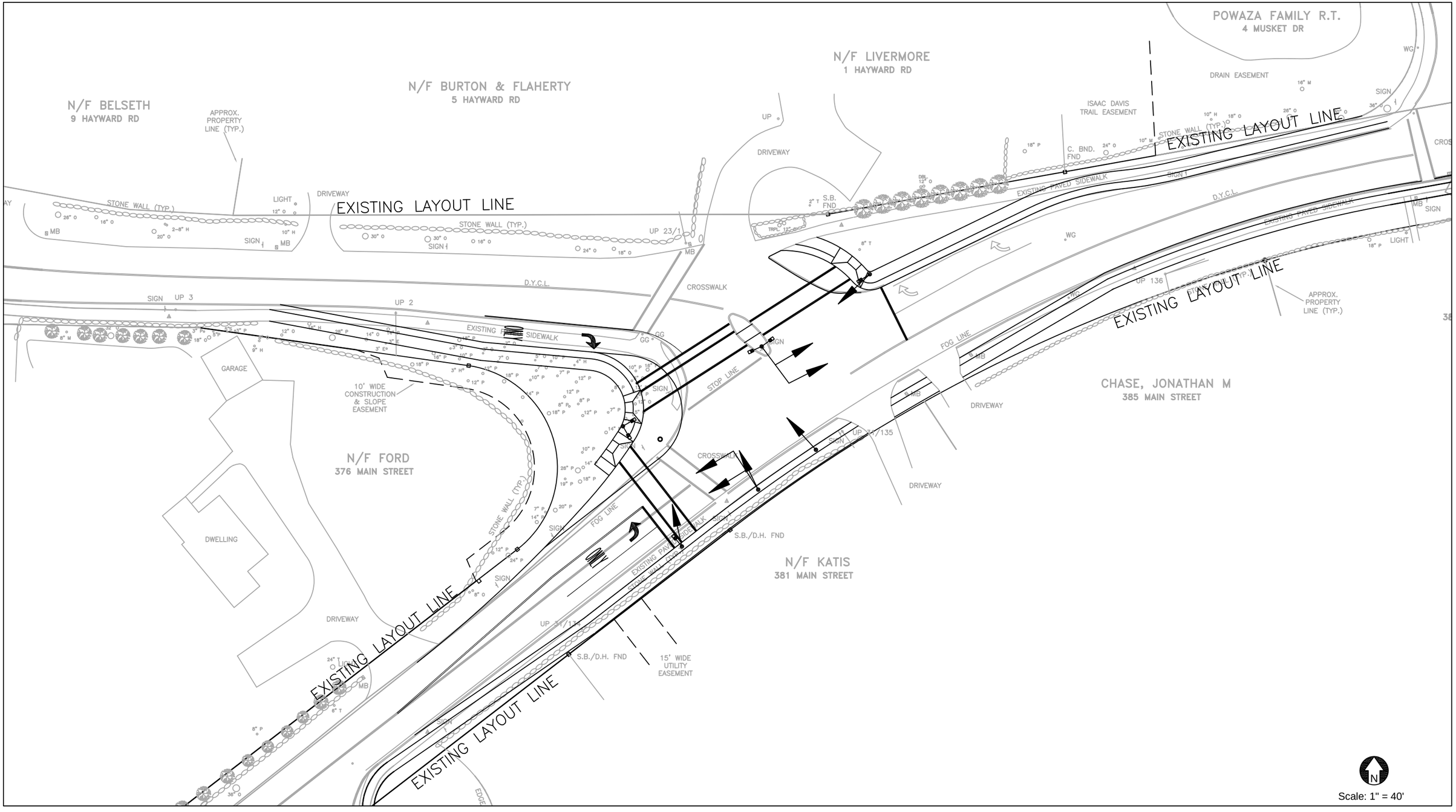


Figure 11. Option 4: Signalized Intersection

Similar to an unsignalized intersection, traffic operations at a signalized intersection are determined through an analysis of intersection LOS. The study team analyzed LOS and delay using Synchro 6. **Table 14** provides LOS criteria for signalized intersections. LOS A defines the most favorable condition, with minimum traffic delay. LOS F represents the worst condition (unacceptable), with significant traffic delay. LOS D is generally considered acceptable.

Table 14. Signalized Intersection Level of Service Criteria

Level of Service	Average Stopped Delay (sec./veh.)
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

Table 15 shows the capacity analysis of the Hayward Road/Main Street intersection if a signal were installed. Although the overall delay and LOS is significantly improved from Existing Conditions, the queuing on several approaches is notable. In the a.m. peak hour, the queue on the Main Street northbound through movement will extend as much as 229 feet. The northern driveway of the Public Safety Facility is located approximately 250 feet south of the intersection, so the signal has the potential to cause queues that block this driveway. Similarly, in the p.m. peak, the signal could cause a queue on the Main Street southbound approach that extends approximately 219 feet; Musket Drive is located approximately 200 feet north of Hayward Road. The Main Street northbound through movement also has potential to back up past the Public Safety Facility driveway in the p.m. peak hour.

Table 15. Future Conditions (2017) Level of Service Summary, Signalized Intersection

Intersection	LOS	Delay (seconds)	V/C Ratio	95th Percentile Queue (feet)
a.m. Peak Hour				
Hayward Road/Main Street	**A**	**7.8**	**0.57**	**—**
Hayward EB left	C	25.4	0.54	87
Hayward EB right	A	7.6	0.20	17
Main NB left	A	4.7	0.13	18
Main NB thru	A	7.3	0.57	229
Main SB thru	A	5.1	0.38	124
Main SB right	A	1.2	0.16	14
p.m. Peak Hour				
Hayward Road/Main Street	**A**	**8.7**	**0.66**	**—**
Hayward EB left	B	18.5	0.38	70
Hayward EB right	A	6.9	0.34	23
Main NB left	B	15.5	0.51	53
Main NB thru	A	8.9	0.66	241
Main SB thru	A	8.2	0.63	219
Main SB right	A	1.5	0.22	17

The cost to construct Option 4 is approximately $680,000, which includes geometric changes similar to Option 2 plus signalization. The order-of-magnitude cost estimate will be refined in the final design process.

Option 5: Roundabout at Hayward Road/Main Street

Option 5 is a modern roundabout. Although a roundabout is an unsignalized intersection, the method of determining traffic operations at a roundabout is slightly different from a normal intersection. It is based on gap acceptance. When a vehicle approaches the yield line at a roundabout intersection, the driver's ability to enter the roundabout is constrained based on the presence or approach of another vehicle. If the time and distance from the waiting vehicle to the approaching vehicle is too small, the waiting vehicle will not enter the roundabout. Thus, the circulating flow of the roundabout contributes to the capacity. If the circulating flow is too high, there will be no gaps for waiting vehicles to enter. The study team analyzed the roundabout using Synchro 6. The HCM methodology for roundabouts does not define LOS or delay.

Option 5 is shown in **Figure 12.** The roundabout's inscribed diameter is approximately 100 feet, similar to the size of the roundabout on Jackson Drive. A modern roundabout is designed to slow traffic; the ideal speed of navigation is around 20 mph. The roundabout can accommodate large vehicles through the use of a truck apron around the center island, on which a large vehicle's tires can ride while it navigates the roundabout. Pedestrian crossings would be provided across all three legs of the intersection. Pedestrian conditions would be considerably safer due to the improved sight lines and slower vehicle speeds at crosswalks.

The capacity analysis results for the Hayward Road/Main Street intersection if a roundabout were constructed are shown in **Table 16.** These results indicate a range of volume-to-capacity (v/c) ratios. The v/c ratio compares the volume in the roundabout to the capacity of each approach. A v/c ratio of 0.85-0.90 is considered close to capacity, while a v/c ratio over 1.00 indicates that a particular approach is operating over capacity.

Table 16. Future Conditions (2017) Capacity Analysis Summary, Modern Roundabout

Hayward Road/Main Street	Low v/c Ratio	High v/c Ratio
a.m. Peak Hour	—	—
Hayward EB left/right	0.35	0.28
Main NB left/thru	0.87	0.72
Main SB thru/right	0.68	0.57
p.m. Peak Hour	—	—
Hayward EB left/right	0.51	0.40
Main NB left/thru	0.97	0.80
Main SB thru/right	1.06	0.88

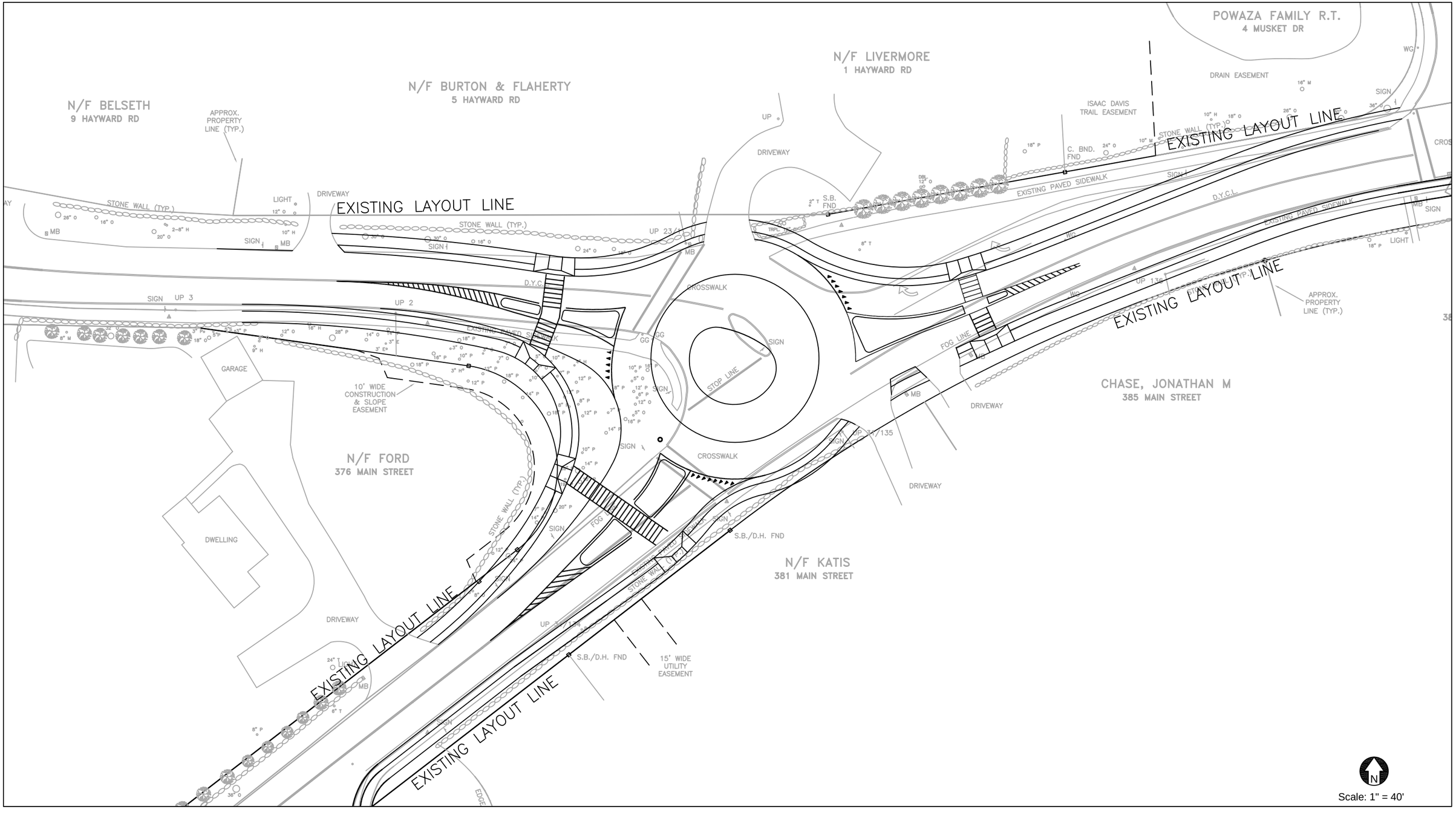


Figure 12. Option 5: Modern Roundabout

Although the queuing is not shown in the above table, a review of the simulation of the a.m. and p.m. conditions indicates that there would be little to no queuing if the roundabout were installed, due to the nature of traffic flow in a roundabout.

The cost to construct the roundabout is approximately $620,000. The cost is similar to that of a signal, because it is assumed that all existing roadway areas would need to be reconstructed. Under the widening and signalization options, it was presumed that most of the existing roadway area can be re-used. The order-of-magnitude cost estimate will be refined in the final design process.

Building Consensus

In order to move forward with improvements at the intersection of Hayward Road/Main Street, one key ingredient for success is community consensus. Consensus does not mean unanimous agreement; rather, it means that those participating in the process can be supportive of the outcome based on their participation and understanding, and on having an open process.

To build consensus on this project, the study team held a second community meeting on November 29, 2007, at Acton-Boxborough Regional High School. At the meeting, the team presented the data it had gathered as well as the options. The audience of about 40 people then broke into smaller groups so the team could gather feedback about the options. One spokesperson from each group reported back with the findings of his/her group.

In general, the attendees were supportive of:

- Installation of a grass strip between the sidewalk and the edge of the road;
- General pedestrian improvements;
- Widening Hayward Road to provide a right turn lane; and
- Further study of tightening up the right turn from Main Street southbound to Hayward Road by eliminating the right-turn lane.

Attendees were opposed to signalization, primarily because of queuing. They also had concerns about a truck apron because of noise. There was concern about widening Main Street to provide either a wider shoulder or an exclusive left-turn lane.

The attendees believed several items had promise, including a pedestrian signal at Musket Drive and the roundabout alternative. They had many questions about queuing at a roundabout, as well as about how the slower speed through the roundabout would impact overall flow on Main Street. There was concern that a roundabout might change the character of this part of Acton.

Recommendations

Based on this review of the analysis of the alternatives, the analysis, and listening to the comments and concerns of the community and stakeholders, the study has formulated the following recommendations regarding the intersection, the corridor, and community consensus.

Intersection of Hayward Road/Main Street

The majority of people attending the second community meeting felt that widening Hayward Road to 2 lanes would be a significant step toward improving the intersection. The study team concurs that this should be the first step in improving the intersection. These improvements would be as shown in Option 1 (**Figure 8).** This would improve the safety of the intersection by providing space for tractor-trailers to make turns to/from Hayward Road without encroaching on the opposing lane of traffic on Main Street.

The study team also recommends that all sidewalks within the project limits be relocated to provide a 3-foot grass strip as a buffer between the sidewalk and the active roadway. As part of the improvements in this first phase, the team also recommends that the crosswalk across Main Street at Hayward Road be eliminated. The sidewalk on the west side of Main Street should be extended to the crosswalk near the Public Safety Facility. Similarly, the sidewalk from the west side of Main Street should be extended around the corner on Hayward Road to the existing crosswalk location.

The second step in improving the intersection should include further study of the modern roundabout. Community members expressed interest in the roundabout concept but were concerned about queuing at the intersection. Due to the number of questions that remained after the November 2007 community meeting, HSH could not recommend a roundabout without further study and community process. There would also be a need for driver education related to roundabouts, since they are a relatively new form of traffic control in the United States, should further process compel the construction of a roundabout. A number of before-and-after studies in the Northeast have found that people are generally skeptical of roundabouts prior to their construction but find them to be relatively easy to navigate and less disruptive than traffic signals after they've been in place for a period of time. Local examples of recently completed roundabouts in Massachusetts include one in North Andover and two in Norfolk by MassHighway. These examples should be incorporated into further study, including videotaping of peak-hour conditions for comparison. If a roundabout intersection meets MassHighway's criteria for installation, the improvements can then be eligible for 100% federal funding for construction.

Also in the second phase, the Town should explore implementation of a pedestrian traffic signal at either the crosswalk at Musket Drive or the one near the Public Safety Facility. Pedestrian safety was a primary concern of those involved in the process to date.

Although the intersection meets warrants for signalization, satisfaction of the warrants does not *compel* signal installation; it merely means that it can be justified based on engineering study. Since congestion

was not raised as a significant concern at the first open-comment community meeting in October 2007, was not an issue at the November 2007 meeting, and is restricted to a short period of each day (according to the traffic data), there is no reason to install a signal to address congestion, which is the basis of the signal warrant analysis. The general consensus was that a signal was not the appropriate treatment for the Hayward Road/Main Street intersection. Although the intersection meets the warrants, people believe that it would create more problems than it would solve. For example, it could introduce queues that would block both the northern Public Safety Facility Driveway and Musket Drive at certain times of day. Furthermore, the significant expense of signalization argues that signalization is unwarranted.

Corridor Improvements

Newtown Road/Concord Road/Main Street

Newtown Road/Concord Road/Main Street should be the next intersection to be improved within the corridor. Its safety issues as well as capacity issues demand attention. One option would be to install a roundabout, which analysis indicates could work. From an operational and safety standpoint, installing a roundabout at this location would improve both. However, the geometry and property lines would need to be carefully considered. HSH has not studied the layout of a roundabout at this intersection to determine what property impacts it might have. The roundabout analysis is included in **Appendix B** for reference and future use.

The Newtown Road/Concord Road/Main Street intersection does meet warrants for signalization, although signalization seems contrary to the character and feel of the Main Street corridor as a whole and Town Center in particular. The signal warrant analysis is included in **Appendix D.** It should also be noted that the intersection is within a historic district, and any improvements will require review by the Historic Commission.

Route 2 Ramps/Main Street

Significant safety and congestion problems are documented in this study. The intersection of the Route 2 Eastbound Ramps/Main Street is more problematic than that of the Route 2 Westbound Ramps. Some issues with the Route 2 Eastbound Ramps appear to stem from downstream congestion on Main Street south of the ramps.

Signals are warranted at the Route 2 Eastbound Ramps (see **Appendix D** for detail), and a signal at these ramps could meter the traffic coming from both the ramps and from Main Street southbound into Kelley's Corner. However, any improvements options at these intersections would need to be carefully studied and include both Kelley's Corner and the Public Safety Facility driveways, in order to ensure that fixing one problem does not create a series of new ones. A pair of roundabouts could work here as well. Improvements at the ramp junctions from Route 2 to Main Street will require coordination with MassHighway as well as their review and approval.

Nagog Hill Road/Main Street

The intersection of Nagog Hill Road/Main Street is another location that requires attention. HSH's review and analysis indicate capacity and safety concerns at the intersection, although the safety concerns are less than those at several other locations along the corridor. The intersection does not meet warrants for signalization (see **Appendix D).** A roundabout could also be constructed at the intersection of Brook Street/Main Street. Constructing a roundabout there would improve both capacity and safety. However, the geometry and property lines at this location would need to be carefully considered due to the proximity of buildings to the roadways. HSH has not studied the layout of a roundabout at this location to determine what property impacts it might have. Minimally, the

Brook Street/Main Street

The intersection of Brook Street/Main Street is another location that requires attention. HSH's review and analysis indicate capacity and safety concerns at the intersection, although the safety concerns are fewer than those at several other locations along the corridor. At a minimum, the horizontal alignment changes recommended as part of the 2001 Corridor Study should be completed. These will provide short-term improvement, addressing the sight distance issue at the intersection. Changing the vertical alignment to address the crest vertical curve, which creates sight distance problems for Main Street northbound approaching the intersection, should also be included in the reconstruction of the intersection.

A roundabout could also be constructed at the intersection of Brook Street/Main Street, improving both capacity and safety. However, the geometry and property lines at this location would need to be carefully considered. HSH has not studied the layout of a roundabout at this location to determine what property impacts it might have.

Continued Community Participation

Throughout all of the above, HSH recommends that the Town continue to engage the community in order to build consensus for the Hayward Road/Main Street intersection as it moves forward.

First Phase:

- Communicate the findings and recommendations of the Hayward Road/Main Street Intersection Study to the public through a press release and a graphic to *The Beacon*;

- Keep study participants informed of the findings and recommendations; send a modified version of the press release and graphic to attendees at the meetings and stakeholders; and

- Inform participants and stakeholders about the process for the design phase of the intersection improvement process; e.g., structure and schedule of the design effort, meetings, etc.

Second Phase:

HSH recommends further study and discussion of roundabouts with the public as the option of a roundabout somewhere along Main Street or perhaps elsewhere in Acton will be revisited soon. As with any new concept, whether it's a new type of laundry soap or a new tax policy, talking through the benefits and potential downsides requires time and exploration of the issues.

- Study roundabout operations, design issues, and driver education needs further, using the Transportation Advisory Committee as a mechanism to engage people beyond those who participated in the Hayward Road/Main Street Intersection Study;

- Undertake a design process for the three other intersections simultaneously that follows the same general process as was done for the Hayward Road/Main Street Intersection Study—get interested and affected residents and businesses to discuss the issues at each intersection; develop improvement alternatives that work together along the corridor; and revise/refine.

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